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JOURNAL OF THE ROYAL SOCIETY OF ARTS

CONTENTS.

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OF THE

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No. 3,496. VOL. LXVIII.

FRIDAY, NOVEMBER 21, 1919.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

ONE-HUNDRED-AND-SIXTY-SIXTH SESSION, 1919-1920.

NOTICES.

NEXT WEEK.

WEDNESDAY, NOVEMBER 26th, at 4.30 p.m. (Ordinary Meeting.) H. B. MORSE, LL.D., late Statistical Secretary, Inspectorate-General of Chinese Customs. BYRON BRENAN, C.M.G., late H.B.M. Consul-General, Shanghai, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

EXAMINATIONS.

The results of the examinations held in April and May-June this year have been printed and sent to all centres. The results contain the names of all candidates awarded certificates in the three stages of the examinations, and also the list of the winners of the silver and bronze medals in Stages II. and III.

INDIAN SECTION.

A meeting of the Indian Section Committee was held on Monday, November 17th. Present: Sir Charles S. Bayley, G.C.I.E., K.C.S.I., in the chair; T. J. Bennett, C.I.E., M.P.; D. T. Chadwick, I.C.S.; W. Coldstream; Sir Frederic W. R. Fryer, K.C.S.I.; Sir Henry Evan M. James, K.C.I.E., C.S.I.; Sir Charles Campbell McLeod; Sir John O. Miller, K.C.S.I.; Sir Prabashankar Dalpatram Pattani, K.C.I.E.; and N. C. Sen, O.B.E.; with G. K. Menzies, M.A., Secretary of the Society, and S. Digby, C.I.E., Secretary of the Section.

The Council have appointed Brigadier-General Sir Percy M. Sykes, K.C.I.E., C.B., C.M.G., a member of the Committee.

PROCEEDINGS OF THE SOCIETY.

FIRST ORDINARY MEETING.

Wednesday, November 19th, 1919; Sir HENRY TRUEMAN WOOD, M.A., Chairman of the Council, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Adams, Thomas Gallon, Newcastle-upon-Tyne.
Aitchison, Captain Leslie, R.A.F., D.Met., B.Sc., Birmingham.
Ann, Alfred Edward, M.Inst.M., London.
Annable, Henry William Coupe, Egham, Surrey.
Ardley, William Guy, St. Albans, Herts.
Atkinson, George Scott, B.Sc., Flixton, Lancs.
Austin, John Corneley Wilson, F.A.I.A., Los Angeles, California, U.S.A.
Baker, John Harry, London.
Bangs, Clare W. H., A.M., Huntington, Indiana, U.S.A.
Barker, William John, London.
Barr, Peter Rudolph, London.
Barrow, Henry, Westcliff-on-Sea, Essex.
Batliwala, Dhunjeebhoy Framjee, Bombay, India.
Battra, Ram Lal, B.A., LL.B., Simla, India.
Beere, William James Edward, London.
Betterton, Walter, London.
Bevan, Charles C., Eccles, Manchester.
Bjerknes, Professor V., Bergen, Norway.
Blackbourn, Lionel Alfred, London.
Blake, William Payne, Boston, Mass., U.S.A.
Bland, Frederick, M.I.Mech.E., Sheffield.
Boucaut, Gordon Lorraine Penn, Adelaide, South Australia.
Brooks, Willoughby Lewis, London.
Bruce, Joseph, London.
Bunge, Julius Henri Otto, Greenford, Middlesex.
Burtwell, George J., London.
Cain, Charles Alexander, J.P., Welwyn, Herts.
Callaghan, Walton John, Sydney, N.S.W., Australia.
Campbell, Robert Hunter, London.
Cathcart, William Hutton, Renfrew.
Chapman, A. Chaston, F.I.C., London.
Cheng Fu Wang, Penchi Hu, Southern Manchuria, China.
Chintamani, Hon. C. Y., Allahabad, India.
Churchill-Smith, Major James, A.I.F., London.
Clarke, Albert James George, Sydney, Australia.
Clinton, Cecil H., Kingston, Surrey.
Clough, Fred., Dumfries.
Cole, Miss R., Ilford.
Connolly, Joseph, Pendleton, Manchester.
Coote, Wilfred Arthur, Sydney, N.S.W., Australia.
Dean, Stephen Woodhouse, London.
Douglas, C. C. Brown, London.
Drew, Verney, Thornton Heath.
Dunlop, Clive V., Sydney, N.S.W., Australia.
Edwards, Henry, M.Inst.M.M., Caversham, Reading.
Farquharson, Arthur Wildman, Kingston, Jamaica.
Fletcher, Stephen Baldwin, Stornaway.
Foster, Frank Geden, Selby, Yorks.
Fowler, John S., London.
French, James Weir, B Sc., Glasgow.
Gandhi, N. P., M.A., B.Sc., A.R.S.M., Benares, India.
Gawley, George J., A.I.E.E., Fleet, Hants.
Gibson, Professor Charles Stanley, O.B.E., M.A., F.I.C., Cairo, Egypt.
Gierløff, Christian, Christiania, Norway.
Goodenough, Frederick Craufurd, London.
Gordon-Cameron, E., A.M.I.E.E., Bombay, India.
Gregg, Alfred W., M.Sc., Chicago, Ill., U.S.A.
Grosch, Direktor H., Christiania, Norway.
Hall, Rev. Henry Wardale, Lincoln.
Hall, Horace Campbell, M.Inst.Met., F.C.S., Chellaston, Derby.
Hampshire, Frederick William, Michleover, Derby.
Hands, Henry James, Moseley, Birmingham.
Haslam, William John, Harrogate, Yorks.
Hawkes, Engineer-Commander Charles John, R.N., London.
Hayes, Henry G., A.M.I.A.E., Weston-super-Mare.
Hayles, Robert B., Andover, Hants.
Headicar, B. Mason, London.
Hethey, Axel, B.Sc., A.R.S.M., London.
Houghton, William Sherwood, Victoria, Australia.
House, Charles E. G., A.R.C.Sc., London.
Howie, William John, London.
Hughes, Frederick, Belfast.
Hughes, Gibbard, M.B.E., Great Missenden, Bucks.
Instone, Arthur Brian, M.Inst.Met., Coventry.
Ionides, Alexander Constantine, Junr., London.
Ireland, Arthur James Thomas, A.M.I.A.E., London.
Jeffries, Zay, D.Sc., Cleveland, Ohio, U.S.A.
Johnson, Joseph M., M.P.S., M.Inst.Met., Harborne, Birmingham.
Johnson, William, Harborne, Birmingham.
Jones, Dudley A., South Farnborough, Hants.
Jones, Horace, Coventry.
Keilhau, Direcktor Dr. Wilhelm, Christiania, Norway.
Kenyon, Alexander, Moss Side, Manchester.
Kerr, James Sinclair, Eston, Yorks.
Kilner, Dr. Frank, B.A., Ph.D., Harrogate, Yorks.
King, J. Foster, Glasgow.
King, Captain Renshaw Weyland Hugh, A.I.F., London.
Kingsmill, C., Sydney, N.S.W., Australia.
Kipling, Herbert Spencer, Birmingham.
Klaveness, A. F., Christiania, Norway.
Knight, Lucien Lamar, M.A., LL.D., Atlanta, Georgia, U.S.A.
Kotval, Kavasji Palanji, London.
Lackie, William Walker, Glasgow.
Lander, Charles, London.
Law, John Stephen, Sydney, N.S W., Australia.
Leach, Frederick Beresford, London.
Leete, Ernest, Wadhurst, Sussex.
Lilley, Herbert Henry, Bombay, India.
Limericke, Y. Anthony Joseph, LL.B., F.C.I., Java, Dutch East Indies.

List, Francis Paul, Luxembourg.
Little, Captain Roy J., R.A.V.C., London.
Lloyd, Frederic, Sheffield.
Lock, Francis Michael, Lieutenant A.F.C., Allandale East, South Australia.
McCormick, James, Malton, Yorks.
Macey, Miss Mabel, London.
McLeod, Robert James, West Drayton, Middlesex.
McMillen, Hugh Harris, Moreland, Victoria, Australia.
Mahamadi, Saeed S., M.B., Ch.B., London.
Mandroo, Labho Ram, Karachi, India.
Maynard, Edwin, M.D., London.
Mayo, Charles Robert, M.I.Mech.E., London.
Mellor, Rev. Percy C., East Grinstead.
Membrey, James Stanley, Northcote, Victoria, Australia.
Milward, William Francis, Sheffield.
Minta, Rev. William Robert, Mus.Bac., Ulverston, Lancs.
Mitchell, Lieut. George Joseph, A.R.C.A., Southport, Lancs.
Morgan, Sir Herbert Edward, K.B.E., London.
Needham, Harry Algernon, Erdington, Birmingham.
Newling, R. S., Simla, India.
Notman, Arthur, Arizona, U.S.A.
Notman, Howard, Brooklyn, New York, U.S.A.
O'Donel, Major Manus Basil Hugh, O.B.E., London.
Offer, M., Montreal, Canada.
Ogilvie, Alexander, C.B.E., London.
Parish, Neville B., Bikaner, India.
Parsons, J., Hong-Kong, China.
Paterson, Thomas Watson, A.M.I.A.E., Liverpool.
Paton, James Lampard, Cottesloe, Western Australia.
Pizzey, Albert Edward Russell, Bristol.
Price, Frederick Charles, Bowden, Cheshire.
Rankin, John, Glasgow.
Rees, Eric, F.R.M.S., Swansea.
Reeve, Harold F., Swansea.
Reilly, F. Myles T., Worthing, Sussex.
Rhodes, John Henry, Leigh, Lancs.
Richardson, Major John Foulkes, A.I.F., London.
Riches, H. Cecil, Cardiff.
Ridge-Beedle, P. D., Glasgow.
Ritchie, Gerald, London.
Roberts, Harold White, Manchester.
Robinson, Lieut. Gerald Hercules, A.I.F., Sydney, N.S.W., Australia.
Rock, Claude William Dunmore, Launceston, Tasmania.
Rothwell, Herbert, London.
Sain, Kanwar, M.A., Lahore, India.
Satow, Konji, B.Sc., Tokyo, Japan.
Shardlow, Howard W., London.
Shedden, Duncan Jones, Birmingham.
Sircar, J. K., F.R.H.S., Bombay, India.
Skidmore, George R. J., Gateshead-on-Tyne.
Sloan, Alexander, Cumberland, Maryland, U.S.A.
Smith, Lieut. Victor Charles, A.I.F., Brunswick, Victoria, Australia.
Snowell, A. E., Purley, Surrey.
Speakman, John Dean, Cambridge.
Spiers, Arthur Hood, M.A., Twickenham.
Spink, John Marshall, London.
Tennyson, Charles B. L., C.M.G., London.
Thomson, George, Junr., Aberdeen.
Tidswell, F. E., London.
Tofts, Captain Crozier Fullerton, Bombay, India.
Tolputt, Herbert, Sheffield.
Tovell, Major Raymond Walter, A.I.F., Melbourne, Victoria, Australia.
Valentine, Charles Robert, Shimoga, Mysore State, India.
Vegas, Santiago, Caracas, Venezuela.
Vig, Christian, Christiania, Norway.
Wadge, John Percy, East Molesey, Surrey.
Warren, H. W. Hugh, A.M.I.E.E., Coventry.
Washburn, Professor E. W., Ph.D., Urbana, Illinois, U.S.A.
Watson, George S., Sheffield.
Watt, Charles, A.M.I.A.E., Malvern, Worcestershire.
Webley, Lieut. Ivan Schroder, A.F.C., London.
Webster, Captain Frederick, M.C., Assoc.M.Inst.C.E., Hawarden, Chester.
Wibberley, Rev. Brian, Mus. Bac., Perth, Western Australia.
Wilson, Frank Denham, Melbourne, Victoria, Australia.
Wimalasurendra, Devapoora Jayasena, A.M.I.C.E., A.M.I.E.E., P.W.D., Ceylon.
Wire, Arthur C., B.A., London.
Wood, Reginald Arthur, Lieut. A.I.F., Perth, Western Australia.
Woodward, Joseph J., London.
Worthington, Captain Percy, R.A.F., Bexley, Kent.
Young, Arthur Primrose, A.M.I.E.E., Kenilworth.
Young, George Washington, New York City, U.S.A.

The CHAIRMAN delivered the following

ADDRESS.

Just five years ago Sir Thomas Holdich, in the address which he delivered as Chairman of the Council, three months after the beginning of the war, was able to say that even in those dark days the Society could commence a new session "with good hopes, fair prospects and no regrets." After the five years of trial and tribulation through which we have passed, it is good to be able to repeat the same courageous hope for the future, the same fortunate retrospect of the past. Five years ago we none of us could foresee what were the prospects of our Society, or of any of the institutions of the country, or even to estimate the chance of its survival. For a time the future looked rather black; but the set-back was only temporary, we rapidly revived, and we are now in as sound and prosperous a condition as ever in our long history. Naturally we have suffered, and shall go on suffering, from causes

beyond our control. High prices and depreciated currency affect institutions as they do individuals, but these are difficulties we share in common with the rest of the nation, and as the nation will surmount them, so will the various units of which the nation is composed.

As it was the need for the better organisation of industry that led to the foundation of this Society more than a hundred and sixty years ago, and as the Society has ever since its foundation taken its full share in the promotion of industrial progress, it has occurred to me that the great problem whose solution is the most pressing task the country has in hand, the Reconstruction of Industry, might well form a suitable subject for our consideration this afternoon.

In the two interesting and suggestive addresses which Mr. Campbell Swinton delivered to the Society during his term of office, he dealt largely with the relations of science and manufactures; but the theme is a wide one, and affords ample scope for further discussion.

Now we are very apt, in considering present conditions, to talk about them as unprecedented, as surpassing all human experience. In a sense that is unhappily true; but humanity has had evil experiences before, though we are fortunately not endowed with a capacity for realising the horrors of past and happily forgotten disasters. The misery, the suffering, the sorrow in England during the Black Death of the fourteenth century certainly (if the relative numbers of the population be considered) far exceeded all we have endured in the past five years; while if we may search in vain for a parallel to the actual atrocities of a war to which has been directed all the knowledge accumulated by centuries of scientific work, yet the threatened results of past wars have been regarded with apprehension equal to any we now entertain as to our future prosperity.

Perhaps, then, it may be worth while, before discussing present prospects, to look back at the last period of the country's peril, the conclusion of the Napoleonic wars, and to see whether there may not be some lessons to be gathered from the past which may serve as guidance for the future. The foundation of the Society was almost contemporaneous with the beginning of the Seven Years' War (1756), and the recovery of English trade and commerce after the Peace of Paris (1763) has its lessons for us now. I will not, however, ask you to go so far back as that, but merely to consider the conditions just a century ago—say, in 1819, the year in which Queen Victoria was born and James Watt died. Then, as now, England had just rescued Europe from the arrogant domination of an unscrupulous autocrat. Then, as now, she was suffering from the losses imposed upon her by the execution of the task, and was well-nigh exhausted by her efforts. She was suffering, too, from internal dissensions and divided councils. Yet she bent to the task of recovery as she bent to the task of conquest, and with a like success. She gained small profit from the results of war, as she will gain little now. Yet in a few years time she was stronger, richer, more prosperous than she had ever been before. Her commerce was extended, her industries increased. She started on that era of commercial prosperity which lasted until Germany, impatient at the slowness with which she was filching from us our trade and our consequent prosperity, precipitated the war which wrecked her own prospects, and from which if we are wise we shall make a fresh start in our industrial progress.

In 1819 the impulse of the Industrial Revolution was dying out. As to the precise period over which the revolution extended, everybody is free to form his own opinion. As good landmarks as any other we may take the dates of Watt's improvement of the Newcomen engine (1754) and of Stephenson's application of Watt's engine to locomotive purposes (1825). At all events by the end of the Napoleonic wars the first period of the industrial revolution was completed. The factory had taken the place of the workshop and steam-power had superseded, for the driving of all machinery, the power of men and animals. But while the use of the stationary engine had become general, the application of steam for locomotive purposes had yet to come. It was this special application of it and the enormous facilities it provided for the transport of persons and commodities which have changed all the conditions of civilised life, and have most profoundly modified its character.

The present year has seen the crossing of the Atlantic by air. In 1819 it was first crossed by a steamer, the "Savannah," partly under steam and partly under sails. It appears to have been fourteen years before another attempt was made, and in 1833 the "Royal William" came from Quebec to London under steam alone. Yet another five years (1838) and the passenger service to America was regularly inaugurated by the voyage of the two steamers the "Sirius" and the "Great Western," which crossed the Atlantic practically simultaneously.

The point in its development which steam navigation had reached a century ago may be judged from the fact that the first time a steamer made a sea voyage in European waters was in 1815, when the "Argyle," renamed the "Thames," made an adventurous and very risky journey from the Clyde to the Thames. The feat was anticipated in America seven years earlier, in 1808, when Stevens, the eminent American engineer and inventor, took the "Phœnix" under steam from the Hudson River to the Delaware, 150 miles or so of the voyage being at sea. In 1818 (just over the century) the "Rob Roy" started to trade between Glasgow and Belfast, and after carrying mails and passengers "with great punctuality" for two years she was sent round to Dover to take part in starting the cross-Channel traffic, the beginning of which must therefore be dated as about 1820.

We have not yet reached the centenary of steam locomotion on land. This must be dated 1925, a hundred years after the opening of the Stockton and Darlington Railway in 1825, though it must be remembered that in 1808 Trevithick had an experimental railway on the ground now occupied by Euston Square. Trevithick was the real inventor of the locomotive, the high-pressure engine with a tubular boiler, but his engine was only an experimental one, and had to be greatly improved by Stephenson and others before it was really fit to accomplish useful work.

The current year may certainly claim to be a telegraphic centenary, for it was in 1819 that Oersted discovered that a compass needle was affected by a neighbouring galvanic current, but it is just over a hundred years since the first practical electric telegraph was completed. In 1816 Ronalds had his apparatus at Hammersmith transmitting signals and complete messages along eight miles of wire, and no doubt the distance might have been considerably extended. Ronalds used frictional electricity, and it might be a little hazardous to attempt an estimate of the distance to which, with the appliances then available, signals could be sent. Probably that distance was less than the inventor thought, but this was a question to be answered by further experiment. The further experiment was never made. Ronalds, having completed his apparatus, invited the Admiralty to inspect it, and the answer he received remains for all time the record example of official ineptitude.

"Mr. Barrow presents his compliments to Mr. Ronalds and acquaints him ... that telegraphs of any kind are now wholly unnecessary and that no other than the one now in use will be adopted."

Let us hope that Sir John Barrow did not himself write the letter sent in his name, for it has over-shadowed the remembrance of much useful official work, and he is known to posterity chiefly as the man who prevented the establishment of the first electric telegraph.

A hundred years ago the great industry of coal-mining was in a state of rapid development. The demand for coal was increasing at a cumulative rate. First came the demand for fuel for the boilers of steam engines. Next, the substitution of mechanical for animal power caused great multiplication of machinery, and the iron needed for the construction of the machines necessitated for its production the consumption of coal. Then the extending use of gas for lighting involved the supply of large quantities of coal, to say nothing of the steady increase of the domestic consumption of coal.

The demand was met by the opening up of fresh coalfields and by carrying the workings to greater depths. In both cases the extension was rendered possible by the knowledge provided by the young science of geology. It was the information contained in the maps which the Society in 1815 helped William Smith, the "Father of British Geology," to publish, that enabled the coal measures to be located with certainty beneath the overlying strata.

The increased depth and the extension of the workings added greatly to the difficulties and dangers of mining coal, and these were met, not only by improved ventilation and by better mechanical arrangements for bringing the coal to the surface, but also by the Safety Lamp, an invention of which it may be sufficient to say here that it was probably (almost certainly) the earliest instance of the application of pure scientific induction to the provision of a desired practical result.

It was mainly in the great textile industry that the influence of the Industrial Revolution was most apparent. Indeed, it was mainly in this industry that the changes were effected which justified the name of revolution. In principle all these changes may be said to have been completed before the period with which we are dealing. That period was one of steady and rapid development, not of considerable or organic change. The time had come, or nearly come, when cotton was "opened, cleaned, spread, carded, drawn, roved, spun, and

weaved" by machinery. After that it was a mere matter of improvement in detail and general development.

A century ago it may be said that the foundations of chemical industry were only being laid. The science of chemistry was, indeed, only gradually being systematised, and was in no condition to hold out much of a helping hand to industry. The problem of making soda from sea-salt, which had exercised many minds and ruined some of those who attempted to find a solution, was solved by the Frenchman Leblanc in 1792, but though the great alkali manufacture was the ultimate result, it took many years to bring about its establishment. Before alkali became an article of manufacture, the makers of glass, soap, etc., had had to rely on natural supplies of potash and soda—the "fossil fixt alkalies" for which this Society offered prizes for many years—and on alkali obtained from the ashes of plants. (It is interesting to note that the limitation of the supply of potash caused by the war resulted in a temporary revival of the Irish kelp-burning industry.) Leblanc's process was introduced into England on a small scale by Losh in 1814, and on a commercial scale by Muspratt in 1823, but it was long before it was established here. Charles Tennant, at the instance of James Watt, had in 1799 utilised Berthollet's discovery of the bleaching powers of chlorine (discovered by Scheele in 1774), and was making "bleaching powder" by treating slaked lime with chlorine. Humphry Davy had already (1807) completed those researches into the nature of the alkalies which served as the foundation later on of many important industries. These were carried out with the great electric battery at the Royal Institution with which he obtained the "voltaic arc." He was also laying the foundations of agricultural chemistry. As regards dyes, we were much in the same condition as when the Society started its career by offering prizes for madder and cobalt, and another generation had to pass before we got, in Perkin's synthetic dyes, any substitute for the ancient materials which served our forefathers.

On the whole, those industries which are now dependent on chemical methods, such as brewing, tanning, distilling, making vinegar, glass and soap, or those wh ch were concerned with such chemical products as were then manufactured, alum, sulphuric acid, gunpowder, copperas, were carried on in the old empirical fashion, and were only beginning to adopt scientific procedure or trying to devise methods for its application.

I do not mean to suggest that this very brief and incomplete sketch of our industrial conditions a century ago affords material for drawing any useful lesson at the present moment, but I am convinced that if it were possible to bring before you in greater detail the history of the expansion of British industries during the first quarter of the nineteenth century, and of the development of the inventions on which that expansion was based, you would realise one outstanding fact, that all our progress was accomplished by individual action, not by State organisation or control. The period to which I am referring may be regarded as the one during which industrial England made the most rapid progress and underwent the greatest changes. In the succeeding period the progress was steady and perhaps greater, but the rate was not quite so speedy, and the changes in means and in methods, though their cumulative effect may have been greater, were less sudden, less violent. Scientific knowledge increased, it was more carefully organised and more systematically applied to industry. The result was not only the modification of existing procedure, and the substitution of new for old methods, but the rise of absolutely new industries founded on scientific discoveries.

This triumph of system and of organisation leads us to demand fresh system and more organisation, and as the German nation grew prosperous and rich by calling in State organisation to the aid and supervision of its industry and its commerce, we English folk—ever distrustful of our own methods—have taken fright and are calling for similar help. This may be right or it may be wrong; it may be wise or it may be foolish. Probably there are some cases in which State control is essential, others in which it is disastrous. At all events, there can be no harm in pointing out that it was not by State-guided organisation that our grandfathers and great-grandfathers made England the workshop and the emporium of the world. No one would suggest that the methods of a hundred years ago are wholly applicable nowadays. They are not. Still, it cannot do any harm for us to realise what they were. We may learn somewhat from them though we certainly cannot go back to them. Theirs was a time of individual, unorganised effort, of struggle against ignorance and the prejudice arising from ignorance. In their days the chief function of the State in its attitude towards invention was

steadily to apply the brake to the wheels of progress, and this function it persistently fulfilled. If an inventor offered his invention to Government, he was snubbed; if he went to Parliament for an act granting facilities indispensable for his invention, he was opposed; if the works he set up to carry out his invention annoyed his neighbours, or affected their crops, he was promptly (perhaps not unreasonably) driven away—and so on. Of course, the State only represented embodied public opinion, and public opinion was adverse to novelty. Now we run to the other extreme: we are credulous, and accept all new-fangled inventions at their face value, often very different from their intrinsic worth. Perhaps, after all, the wisest view to take is to admit that it is the nature of man to swing from one extreme to another like a pendulum, and to remember that if the pendulum swings to and fro, making no advance, still all the same the clock goes steadily on.

Whatever may be the comparative value of England's contributions to the advance of pure science in the early days of its growth—and the work of Newton, Boyle, Hooke, Cavendish, Priestly, Davy, Dalton, Faraday, compares not unfavourably with that of Galileo, Lavoisier, Volta, Scheele, Huyghens, Kepler, Descartes, Copernicus, Richter, Berzelius, Avogadro, Laplace, Euler, Ampère—there can be no question that it was in England, or rather in Britain, for Scotland contributed her share, that science was first utilised for the benefit of industry, and that the applications of science were regularly developed until England became the workshop of the world. It was here that the steam engine was perfected and utilised first for supplying power to all forms of stationary machinery, then for purposes of transport over land and sea. It was here machinery driven by mechanical power took the place of implements and appliances worked by human or animal power, first in the great textile industry, then in every form of manufacture by which human needs are now supplied. It was here that chemical products, often devised in other countries, were developed on a manufacturing scale and by improved methods, until the commerce resulting from our industries eclipsed that of every other nation. For a time we had the field almost to ourselves, but naturally we soon had our rivals. America was perhaps the earliest. In the development of the marine steam engine she took an important part, and when at a somewhat later epoch she became a great manufacturing country, her factories made more rapid progress than our own.

The industrial development of Germany hardly dates back for more than a generation, but the marvellous rapidity with which she assimilated the accumulated knowledge of the world, and the concentrated energy with which she devoted herself to the task of developing her resources, soon placed her ahead of all the other nations in the field of scientific industry.

In the brilliant address which Sir Dugald Clerk gave us four years ago in this room, he demonstrated that it was not the German's superior intellectual capacity but his power of adaptation, his energy in working out the original ideas of others, his unlimited industry, his unwearied and patient application that had been the cause of his success. That success fully deserves our admiration, but it does not justify the humiliating subservience with which before the war we regarded his methods and his system. We acquiesced meekly in his superiority, and accepted his own boastful estimate of his own merits. He told us that he had beaten us in the pursuits of peace, and that he was going to knock us out once for all in war. We may admit now that we believed both statements, but when it came to the practical trial we found out that his ultimate conclusion was incorrect, and now we are going to show that his original statement was not necessarily to be accepted without demur.

There need be no hesitation in admitting that before the war Germany had gone far ahead of us in the application of chemical science to industrial purposes. It was the primary object, the first duty of the chemist to discover what things are made of, what the constituent elements are of which substances are composed. Having by generations of study achieved a mastery of analysis, he was led on to synthesis, the attempt to form new combinations, or to reproduce natural combinations, of the materials he had separated. Among the earliest labourers in this direction the most striking success must be credited to Perkin (though he was working under the direction of the German, Hofmann), who tried to manufacture artificial quinine, and produced a new colouring material.

On this discovery was based the great coal-tar colour industry, which, after being successfully carried on for a few years in this country, was bought up and transferred to Germany

where it formed the basis of the vast chemical industry which has been developed there in the last fifty years. How this development was effected is well known. Immense capital resources were devoted to it, the most skilful chemists were sought out, trained and paid to devote themselves to experimental research. No expense was spared in fitting laboratories or in pursuing lines of investigation often apparently unpromising. Definite objects of inquiry were selected and their investigation pursued until the object was obtained or proved unattainable, with the ultimate result that, as regards the dyeing industry, artificial productions have been substituted for natural materials, a host of new dyes have been devised and in certain cases the old materials have been actually manufactured by cheaper and more rapid means than the costly and slow processes of nature.

But the scientific investigations originally directed to the production of new and cheaper dye-stuffs, have had far-reaching effects in other directions. The same principles were applicable, and were applied, to other manufactures. To pursue the history would require a volume, and its discussion could only be usefully carried on by a skilled and experienced chemist. Perhaps no better subject could be selected for a course of Cantor Lectures than the industrial applications of synthesis, "the production synthetically —that is by the union of elements—of compounds previously obtainable only from natural sources." Some few of these have lately been described by Sir William Tilden, and a typical one may be mentioned as an example, the artificial production of ammonia by the combination of hydrogen with atmospheric nitrogen, and the manufacture of the nitrates required for explosives by causing the ammonia to combine with atmospheric oxygen, and thus converting it into nitric acid.

In this last-mentioned process we have an instance of the manner in which the Germans have employed the processes of industrial science to the manufacture of munitions of war. The real importance, however, of the process is, not that it facilitates the manufacture of high explosives, but that it provides the means of producing nitrates in large quantities, and at a cost which enables them to be employed as agricultural fertilisers, so that if it justifies the anticipations of its value expressed by competent authorities, it will be the final realisation of the prophecy made by Sir William Crookes just twenty-one years ago. In the address which he delivered at Bristol in September 1898, as President of the British Association, Sir William said: "The fixation of atmospheric nitrogen is one of the great discoveries awaiting the ingenuity of chemists," for though many attempts had been made "no process has yet been brought to the notice of scientific or commercial men which can be considered successful whether as regards cost or yield of product." In what were then regarded as visionary speculations, saved only from derision by the eminence of the speculator, Crookes showed that the future food supplies of the world depended on an adequate provision of nitrate of soda, a fertiliser practically then to be obtained only from the deposits of Chili saltpetre. As a popular illustration of the abundance of nitrogen, its present uselessness and its potential value, he told his audience that the Colston Hall in Bristol, in which he was then speaking, actually contained about twenty-seven tons of nitrogen, in the gaseous state worthless but in the form of nitrates of soda worth some £2,000. He indicated the method by which the problem was ultimately solved, the use of electricity generated by dynamos driven by water-power, and finally declared that "The fixation of nitrogen is vital to the progress of civilisation."

How the problem was first solved was described in the paper read before this Society in 1909 by Herr Sam Eyde, but despite all the improvements which have since been made, the nitrogenous fertilisers produced before the war, calcium nitrate and calcium cyanamide, were not of equal value with the nitrates of soda and potash, while their comparatively high cost was an obstacle to their extensive use. There appears to be every reason to believe that by the new process the cost of production has been greatly lessened. It is also stated that the economical working of the process does not depend on the use of water-power, and there therefore appears no reason why the manufacture should not be carried on in this country just as well as in Germany.

And there is room enough and to spare in this country, both for the introduction of new industries and the development of old ones. It is to be remembered that we have during the past five years initiated and completed a vast manufacture of war munitions. The time has now come when we have to utilise as best we can, for the purposes of industry and commerce, the factories set up for purposes of war.

The direction our labours have to take was well indicated by the excellent collection brought together at the British Scientific Products Exhibition which was held this summer in Westminster. This collection illustrated in a most forcible manner the progress which had been made during the war, and in spite of all the difficulties of the war, in substituting purely British products for numerous manufactured articles hitherto made exclusively or chiefly in Germany. The great and successful efforts which have been made to establish in England the manufacture of dyes are well known, and there is every reason to believe that in the future we shall be able, if not to supply all our own requirements, at least to compete on equal terms, in our own markets and in the markets of our Allies, with those rivals who once held a practical monopoly of this great industry. The Exhibition brought to public knowledge what was already known to scientific students, that similar efforts were being made to extend the influence of scientific knowledge in many branches of industry which had hitherto either been neglected in this country, or had been conducted too closely on the old empirical lines. It is certainly not true to say—as some enthusiastic advocates seem inclined to say—that science was ignored by British manufacturers. It was not. In certain trades—two for instance of the most important of all, the iron and steel manufacture and the great alkali trade with all its ramifications—scientific research was utilised to the full, while in numerous others it was gradually becoming more and more important. But our advance was much too slow. Our manufacturers were too reluctant to adopt new methods and to abandon old plant. They hesitated to pay enough to secure the services of highly trained experts. They were reluctant to risk capital in costly researches which might prove unsuccessful. They never dared to establish great laboratories, with highly paid experts in charge, for the business of investigations which might prove unprofitable. The result was that they were surpassed, often superseded, by their rivals in Germany and America, who did all these things, and their business was quickly drawn away, and passed into their rivals' hands.

We have had a rude awakening. The process seems to have been effective, for we have certainly realised our position. It remains to see whether we can improve it, and there seems to be no reasonable doubt that we can. So far as the application of science is concerned the nation is thoroughly aroused. The Government took the question up seriously very early in the war, and in the summer of 1915 it established a definite Department for Scientific and Industrial Research. A very clear and excellent account of the work and objects of the new Department was given to the Society in the interesting paper read last session by its Secretary, Sir Frank Heath, and the official record of its proceedings will be found in its annual report (the fourth) issued at the end of August last.

The formation of a Government Department of Scientific and Industrial Research was not received with unmixed satisfaction by the industrial world, especially by those who have a general mistrust of the Government Danai, even when they come, as in the present case, *dona ferentes*. This prejudice, however, is perhaps as unwise, though certainly more reasonable than that of our Socialistic friends who would turn over the control of all our industry to Government, and it is naturally felt —or at least expressed—chiefly by representatives of those great manufacturing firms who are already applying scientific research in their own businesses, and naturally prefer to retain the results for their own benefit rather than to share with their rivals the advantages of a larger scheme.

But whatever the opinions, biased or unbiased, of commentators, there can surely be little doubt that the experiment was a wise one, and well worth trying. It is too soon yet to look for big results, though eighteen research associations are already in existence and some discoveries of practical value have already been achieved. The Department has only recently organised itself, and this it has done extremely well, and in very practical fashion. The controlling body, Advisory Council as it is termed, is a committee of scientific experts, very similar to the committee of the Royal Society which managed the National Physical Laboratory until its recent transfer to the Government, and though it is nominally under the control of the "Lords of the Committee of His Majesty's Privy Council," that committee is believed to hold no meetings, so that it is for the special purpose an absolutely ideal body with the sole function of receiving an annual report.

It may reasonably be anticipated that the best part of the Department's work will be that carried out by the Industrial Research Associations which are being established in various trades. Whenever a trade forms such an

association and contributes sufficiently to its funds, the Department contributes an equivalent amount, up to a certain limit, leaving the disposal of the money (under certain reasonable conditions) in the control of a board appointed by the trade. It would appear, therefore, that the constitution of these associations realises what some astute educational expert said was the ideal of a State system of education, the maximum of Government money and the minimum of Government control. From the latest report it appears that a satisfactory response is being made to the offer. Many such associations are getting into work, and are already beginning to tackle various technical problems requiring scientific investigation. One remark may perhaps be permitted. It is not only the great industries, engineering, chemical and textile, that require scientific help. Many of our smaller trades want it just as much and are less able to get it. To them the new organisation should prove of the utmost value, and if trade jealousies can be avoided—as they should be—members of such trades should by joint action be enabled to obtain much useful knowledge they can hardly be expected to hunt out by individual effort.

The greatest problem, however, in industrial science—greater even than the substitution of swift and economical methods of manufacture for the slow and cumbrous processes of nature—is the provision of new sources of power. For ages man had to rely on his own strength aided by the powers of the few animals he had subordinated to his service. The source of all his available power was the food consumed by himself and his cattle. Gradually he learned to utilise some natural forces, the force of the wind and that of moving water. Of these the wind only was of much importance, as it afforded for centuries the only motive power by which his ships were driven over the seas. On land the wind was of small service, though wind-mills are very ancient, and certainly were used for grinding corn by the Romans and probably by earlier peoples. Water-mills for the same purpose were perhaps a little later, though there are references to them in classical writers. Whether, except for grinding corn, and possibly other materials, any mechanical power was used until quite modern times may perhaps not be easy to say. I doubt whether there is any application much older than the tilt hammer used by the Sussex and other iron-makers. As time went on, wind and water-power came in for various purposes, first pumping, and later for driving heavy machinery, saw-mills, rolling-mills and the like.

Then, two hundred years ago, the construction of the first practical steam engines enabled the power of heat to be utilised for mechanical purposes, and as coal was the best and most abundant fuel, coal became the great source of the energy required. Till recent years, except in certain localities where timber was abundant, coal has remained the one available fuel for the supply of the heat-engine, but the utilisation of oil now provides a supplementary source of the highest value. The supplies, however, of coal and oil are not illimitable, and the increasing demand for both is bringing nearer and nearer the not very distant date when those supplies will be exhausted. Oil in greater or smaller amounts is found all over the world. Opinions seem to vary as to the total supplies available, but there seems good reason to believe that vast amounts will be forthcoming from new fields as well as from fields already known.

In the meantime the search for fresh sources of energy occupies the earnest attention of many of our wisest minds, and though their discovery seems as remote as ever we may after all be on its threshold. It is to be remembered that what is really wanted is not a new source of energy, but some means of controlling and so utilising forms of energy already well known. The energy of chemical combination has only so far been utilised for destructive purposes. Attempts to make a gunpowder engine preceded the completion of the steam engine, but no man has ever succeeded in utilising the force of explosives for any mechanical purpose except that of imparting velocity to bullets and cannon balls, or of rending and shattering matter by the sudden strains and pressures arising from heat generated by the instantaneous combination of certain chemical elements.

Sir Oliver Lodge, our latest Albert Medallist, has recently drawn attention to the possibilities of utilising the atomic energy the existence of which has been made known to physicists by the discovery of radium. Sir Oliver tells us of forces which seem to bear something like the same relation to the forces of chemical combination as these bear to the powers we get in a steam boiler, but neither he, nor anybody else, is able to suggest any device by which we might be able to control this illimitable strength to the service of man. Only a small portion of it is wanted. It must be remembered that the steam engine utilises less than a fifth of the energy residing in the fuel, the internal-com-

bustion engine not much more than a quarter.* There is abundant margin for waste, and coming generations may be quite satisfied if their earlier atomic-energy engines can utilise a tenth of the abundant store available.

However, I am glad to be able to congratulate the Fellows of the Society, in that they will shortly have the opportunity of hearing from Sir Oliver Lodge himself what he has to tell us on this important subject. We shall gladly listen to what I am certain will be a clear and philosophical description of the powers that are available for our use, though it may not yet be possible to foretell the precise manner in which they may eventually be employed.

Sir Charles Parsons, in the address which he recently delivered to the British Association at Bournemouth, referred to a long-cherished notion of his own for utilising the internal heat of the earth by sinking shafts deep enough to reach a level where the temperature was sufficiently high. Such a bore-hole might be twelve miles deep, might cost £5,000,000, and might take eighty-five years to construct. Sir Charles considered the engineering conditions feasible, but admitted that it was quite uncertain whether the pressure at such depths might not cause the rock to crush in and destroy the shaft. But he is evidently a little keen on trying the experiment, for he urged the value of the scientific knowledge to be gained as a justification for it. At present the only attempt to utilise this source of energy appears to be that carried out in certain volcanic regions in Italy, where turbines are actually being driven by high-pressure steam obtained from bore-holes. As Sir Charles Parsons said, "it seems indeed probable that in volcanic regions a very large amount of power may be in the future obtained, directly or indirectly, by boring into the earth, and the whole subject deserves serious consideration."

But while we are insisting on the necessity of a proper use of all the benefits we have derived from scientific progress, is it not just worth while to remember that there is another side to the question? We have perhaps devoted ourselves too ardently to an idolatry of science, and we have had a bitter lesson that every human institution however beneficent has also its evil side and is productive of harmful as well as good results. The apostles of every new religion have dangled before the eyes of their disciples promises of a millennium more or less immediate. Humanity has revolted, and every creed in turn has marked its progress by persecution and intolerance. Great as are the benefits which Christianity has conferred on mankind, its generous altruism, its benevolence to the weak and suffering, its cultivation of the noblest ideals, its pure and unselfish morality, it has in the course of its triumphant progress been the direct cause of infinite human misery and suffering.

So has the progress of science during the past five years succeeded in off-setting the benefits it has conferred on mankind during the past century, by becoming the instrument of more concentrated human agony than the world has ever known since history began. Five years ago we were continually exulting over the benefits conferred on humanity by the rapid progress of scientific knowledge. We cannot date the commencement of the practical application of science much further back than a single century. If we could put into one scale the benefits received in a hundred years, and into the other the misery produced by scientific inventions in five, which way would the balance of human happiness swing?

To take up this point of view is not to attack science or to decry religion—efforts to my mind of equal ineptitude and folly; it is merely to follow the advice of the wisest of men, the father of all modern philosophy, though he lived nearly 2,500 years ago, who beyond all things inculcated the value of moderation—temperantia—σωφροσύνη, and like all wise philosophers distrusted and condemned the folly of extreme views.

The precise share which the Society can most efficiently take in the great task of reconstructing British industrial organisation it is hardly possible—perhaps hardly desirable—to anticipate. It will willingly accept, and to the best of its ability discharge, any duties it can usefully undertake. It must be remembered that its influence is very widespread, and extends to every corner of the Empire. At least a third of its total membership consists of residents beyond the seas, and, indeed, includes a certain proportion of actual foreigners

* The most recent estimate of the amount of energy utilised in our best engines will be found in a paper read by Sir Dugald Clerk to the North-East Coast Institution of Engineers in July last. According to Sir Dugald Clerk's calculations the best steam engine in 1914 utilised 16·8 per cent. of the theoretical energy in the fuel, and the best gas-engine 28·4. The limiting efficiencies which appear to be the highest possible with present knowledge, that is to say theoretically possible with engines designed but not yet constructed, are given by Sir Dugald as for the steam turbine 28 per cent., and for the internal-combustion engine 46 per cent.

as well as residents in foreign countries. We have many American members, and shall be glad to have many more. This is one chief source of the Society's strength and of its growing influence.

Since its foundation in the middle of the eighteenth century, one of the principal objects which the Society has consistently and persistently held before it has been the application of scientific knowledge to the purposes of practical life. Long before such a thing as scientific research can be said to have existed, except indeed in a sporadic form, and as the pursuit of individual inquiries, it was searching for new industrial materials, encouraging new methods of employing them, and rewarding new devices for treating them. This was all done in an empirical and unsystematic fashion, but in the days when science itself was as yet unsystematised and undeveloped, it were idle to expect any regular system for its useful employment. It was not until the later years of the eighteenth century and the earlier of the nineteenth that chemistry and physics, created and established by the devotion of a succession of great philosophers, were first systematised and then devoted to human benefit by a series first of brilliant students and afterwards by a number of energetic inventors, manufacturers, and engineers.

All the while the Society was taking its share in the work of progress, though as time went on new and more specialised institutions arose to deal each with its own particular branch of the multifarious and complicated organism. During its long history its methods have changed from time to time, but it has always discharged the special duty of diffusing information about the practical results of scientific research. Professor Tyndall was once invidiously, but quite correctly, described as the most eminent *vulgarisateur* of science, for the reproach suggested by the English equivalent is, I believe, by no means involved in the French epithet. It is as essential that scientific discoveries should be published as that they should be made, and the provision of a regular organisation for disseminating knowledge of scientific progress is almost more needed than the provision of an organisation for promoting it. Science may develop by individual and silent effort, but it can render no help to human progress until the outcome of that effort is published abroad.

It is now, and has been for a great many years, regarded as the principal duty of the Society that it should provide its members, at their regular meetings, with the opportunity of hearing from the lips of the discoverers themselves, or of other competent persons, accounts of those applications of science to purposes of daily life of which our time is so productive. This duty it has effectively discharged, and the testimony is to be found in the columns of its *Journal*, comprising as they do an encyclopædic history of the progress of industrial science for a period of much more than half a century.

The Society has originated many new projects, and has promoted the progress of many novel ideas, and as opportunity serves it will continue in the future its useful labours of the past. The times, as I said before, are hard for institutions as for individuals. Our resources are limited, but our numbers are increasing, and so long as we have this proof of public approval there is no reason why we should not look forward to our future with serene confidence, as we are justified in looking back upon our past with legitimate pride.

After delivering the address the Chairman presented the Society's medals which were awarded for papers read during last Session:—

At the Ordinary Meetings:—

Edward C. de Segundo, Assoc.M.Inst.C.E., M.I.Mech.E., M.I.E.E., "The Removal of the Residual Fibres from Cotton Seed, and their Value for Non-textile Purposes."

Sir Frank Heath, K.C.B., Secretary, Department of Scientific and Industrial Research, "The Government and the Organisation of Scientific Research."

Walter Leonard Lorkin, A.M.I.E.E., "Electric Welding and its Applications."

W. Norman Boase, C.B.E., "Flax—Cultivation, Preparation, Spinning, Weaving."

In the Indian Section:—

Brigadier-General Lord Montagu of Beaulieu, C.S.I., "Aviation as affecting India."

In the Colonial Section:—

Professor John Cunningham McLennan, O.B.E., Ph.D., F.R.S., "Science and Industry in Canada."

Mr. Alan A. Campbell Swinton, F.R.S., said it was his pleasant duty to ask the meeting to accord a very hearty vote of thanks to their Chairman for the exceedingly interesting address he had delivered. The Society was to be congratulated in that Sir Henry Wood had brought his long connection with it to a culmination by becoming Chairman of the Council—the highest honour the Council could bestow. Sir

Henry was the embodiment of all that the Society stood for. The principal object of the Society was the dissemination of knowledge—a very important function indeed. The majority of scientific discoveries and inventions were put forward by their originators in language which it was difficult for the average man to understand, and the aim of the Society was to explain all such discoveries in a more popular manner. Manufacturers and others, whose business it was to apply these discoveries to industry, could not afford the time to follow all the details and ramifications of scientific research, and an Institution like the Society of Arts performed most useful work in placing the results of such researches before them in a manner which would enable them to apply them to their industries. The Chairman's address was a record of what had been done by the Society in that connection during the past century, and it was a record of which they might well be proud, and which they hoped to continue in the future under his auspices. He asked the meeting to accord their heartiest thanks to Sir Henry Wood for his admirable address.

The Hon. Richard Clere Parsons, in seconding the motion, said the exceedingly illuminating address which the Chairman had given them explained very clearly the part that the Germans had played in connection with industry in the past. It was now their duty to consider how they were going to profit as the outcome of the terrible war which had at last been brought to an end. He thought that the industries which had been so much weakened by German competition in the past would now recover, and it was their duty to see that that recovery was maintained, and that trade was not allowed to go back into enemy hands. Sir Henry Wood had covered the ground most completely in his address, and had shown the great part which their Society had played in assisting the industries of the country, and that was a part which they must continue to play in the future. He hoped that Sir Henry would enjoy the best of health during his term of office and for a long time to come.

The vote of thanks was then carried with acclamation.

The Chairman (Sir Henry Wood) said he was very much obliged to the meeting for their expression of thanks and for the patience with which they had followed his address.

The meeting then terminated.

MANGANESE MINES IN ECUADOR.

The manganese mines of Ecuador, which are becoming known in the United States as a number of shipments of the product have been sent there recently, are situated near the town of San Antonio, Province of Pichincha, and cover an area of about one and a third square miles.

According to a report by the United States Consul-General at Guayaquil, the principal deposit so far discovered consists of a blanket vein of manganese three to nine feet thick, and an extension of some 21,000 sq. ft., a portion being exposed. Samples from many other deposits in the vicinity, of undetermined extent, appear to be of equal quality, from which it is assumed that the available quantity of ore reaches many thousands of tons.

Work was begun at the principal deposit in February, 1918, with a limited force and in a primitive manner, about five tons being the daily output with ten men working. The ore extracted was dried in the open air and bagged for export, resembling gravel in appearance.

An assay made in New York gave the following percentages: Manganese, 46·36; iron, 1·55; copper, 0·02; phosphorus, 0·14; silica, 6·44. Other samples showed 53·2 per cent. of manganese; some have a higher percentage of silica, and still others show limestone. The small quantity of phosphorus should be noted.

The mines are 7,874 ft. above sea-level; the climate is healthy; and the rainy season lasts from January to April, with a small rainfall. The district is wholly volcanic, partly covered with sand, and the Guaillabamba River passes through a deep gorge near by.

No experienced miners are available, but the native workmen, of which the supply is sufficient, are easily managed and learn readily. Quito, the railway terminus, is twenty-eight miles from the mine; the road is fairly passable to mule traffic, and could be fitted for wagons by constructing a small bridge.

OBITUARY.

Admiral Charles John Rowley.—Admiral Charles John Rowley died at his residence, Holmesland, Botley, Hants, on the 11th inst., at the age of eighty-six.

He entered the Navy in 1844, and was made a lieutenant ten years later. He served in this rank on the "Curlew" and "St. Jean d'Acre," and was present at the operations before Sebastopol in 1854-5. He also took part in the Azoff Expedition and the capture of Kimburn Kertch Yemikali. For these services he received the Crimean Medal, with the Azoff and Sebastopol clasps, and Turkish decorations. He was promoted commander in 1861, and captain in 1866, commanding, among other vessels, the "Pallas" and the "Iron Duke." In 1884 he was advanced to flag rank, and in 1887-8 he was second in command of the Channel Squadron. He became Admiral in 1895, and retired in 1897.

Admiral Rowley had been a member of the Society since 1877.

Earl Brassey, D.C.L.—The death of Earl Brassey took place on the 12th inst. as the result of an accident in which he was run over by a taxi-cab.

Born in 1863, he was educated at Eton and Balliol College, Oxford, of which he was elected later in life an honorary Fellow. When the South African War broke out he went with the Sussex Yeomanry on active service. After the fall of Pretoria in 1900, he became first acting Civil Commissioner for the British Government there, and from that time onwards he took a deep interest in South Africa and in imperial interests generally. His views on these subjects he embodied in his book, "Problems of Empire."

Mr. Brassey made several attempts to enter the House of Commons, but without success. He was, however, Assistant Private Secretary to Lord Spencer at the Admiralty, and, like his father, he was intensely interested in the Navy. He edited the *Naval Annual* from 1890, and he contributed special chapters on the progress of the British Navy, and the relative strength of the navies of the world.

In addition to his political work he was a very good friend to his "Alma Mater," and was the founder of the Oxford University Endowment Fund. He also served on the Archbishop's Committee on Church Finance in 1910 and 1911, and was Chairman of the Central Board of Finance of the Church of England. During the war he succeeded in controlling mines in Sardinia hitherto owned by German firms; and in 1917 he performed good work in Rome in connection with the Mediterranean lines of communication from Cherbourg to Taranto. He was made a Commander of the Crown of Italy.

Lord Brassey succeeded his father as second earl in 1918. The first earl had been a member of the Royal Society of Arts since 1862, and served on the Council for some forty years. The second earl was only elected a Fellow last year.

GENERAL NOTES.

The Prickly Pear in Australia.—A bulletin issued by the Institute of Science and Industry (Commonwealth of Australia) deals with one of the greatest obstacles to pastoral and agricultural progress in a large portion of the Commonwealth. An area of over 20,000,000 acres is infested with prickly pear in Queensland, and an area of over 2,200,000 acres in New South Wales. The rate of increase of the pest is estimated at 1,000,000 acres per annum. No discrimination is shown in the land attacked. Rich country is as quickly overcome as poor country, and in a short time is rendered unproductive and valueless. The plant is extremely difficult to eradicate, and no satisfactory machine for destroying it has yet been invented. The manufacture from it of alcohol, paper or cardboard, potash, and various other materials has been suggested, but the fact that prickly pear contains a very large percentage of water makes its profitable commercial utilisation very unlikely.

East African Markets.—One effect of insufficient tonnage has been the entrance of South Africa into the markets of Equatorial Africa. Mr. T. Sleith, M.B.E., who has recently visited the territories in question as special Trade Commissioner to the Union Government, was instructed to investigate the position, not only as to exports from South Africa, but as to the supply of various raw materials required in the Union for primary industries. In a valuable report which has been presented to the Union Houses of Parliament, Mr. Sleith says he does not anticipate any large volume of trade for some time to come, but considers that as South African manufacturers are now in the East African markets, every effort should be made to retain that share of business which has fallen to them. Central Africa, as a source of certain raw materials and products, he continues, is of primary and paramount importance to the Union, and as its industries extend and develop this will become more apparent. "In these territories is an unlimited supply of copra, palm-oil, ground-nuts, sim-sim, sisal, beeswax, hides and skins, and other commodities equally important to industrial manufacture, and it is to Central Africa that the Union must look, owing to the geographical advantage, which will be much more pronounced when shipping and freights resume a more normal condition." Many merchants complained to Mr. Sleith of the way in which certain articles of Union manufacture—chocolates, biscuits, tobaccos, and cigarettes—turned out. "It is quite obvious," he declares, "that the biscuits and chocolates do not keep as long as the English article." He also urges the need for improvement in packing methods.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

November 26.—H. B. Morse, LL.D., late Statistical Secretary, Inspectorate-General of Chinese Customs, "British Trade in China." Byron Brenan, C.M.G., late H.B.M. Consul-General, Shanghai, will preside.

December 3.—John Westall Pearson, Chairman and Director, British Oil and Cake Mills, "The Oil Seed Crushing Industry." The Right Hon. Lord Lamington, G.C.M.G., G.C.I.E., will preside.

December 10.—Sir Oliver Lodge, D.Sc., Sc.D., LL.D., F.R.S., "Some Possible Sources of Energy." (Trueman Wood Lecture.)

December 17.—Constantine Grunewald, late Chief of Intelligence Department, Russian Ministry of Trade and Industry, "The Present Economic Position of Russia, and some Aspects of its Future Development."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 p.m.:—

DECEMBER 9.—SIR EDWARD DAVSON, President of the Associated West Indian Chambers of Commerce, "Problems of the West Indies." LIEUT.-COLONEL L. S. AMERY, M.P., Under-Secretary of State for the Colonies, will preside.

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.

DECEMBER 18.—P. J. HARTOG, C.I.E., M.A., Member of the Calcutta University Commission, 1917-1919, "Some Problems of Indian Education."

Papers to be read after Christmas:—

BRIGADIER-GENERAL EDWARD MAITLAND, D.S.O., "The Commercial Future of Airships."

SIDNEY PRESTON, C.I.E., "English Canals and Inland Waterways."

BRIGADIER-GENERAL SIR HENRY P. MAYBURY, K.C.M.G., C.B., M.Inst.C.E., "Road Transport."

CHARLES H. SHERRILL, "Stained Glass."

ALFRED E. HAYES, General Secretary, English Language Union, "The English Language and International Trade."

JAMES CURRIE, C.M.G., Ministry of Labour (Training Department), late Principal, Gordon Memorial College, Khartoum, "Industrial Training."

LADY INGLEFIELD, President, Buckinghamshire Lace Association (North Bucks and Bedfordshire), "The Hand-made Lace Industry."

GRAILY HEWITT, "Rolls of Honour."

ALFRED H. POWELL, "Ancient Cottages and Modern Requirements." The Right Hon. EARL FERRERS will preside.

CHARLES CROWTHER, "The Arts and Crafts of Japan" (with examples from the author's private collection).

SIR CECIL HERTSLET, late H.M.B. Consul-General for Belgium, "The Ruin and Restoration of Belgium." EMILE CAMMAERTS will preside.

WILLIAM CRAMP, D.Sc., M.I.E.E., "Pneumatic Convoying Plants, with special reference to the Transport of Grain."

L. GASTER, "Industrial Lighting in its relation to Efficiency."

H. M. THORNTON, "Gas in relation to Industry and Housing."

LIEUT.-COMMANDER NORMAN WILKINSON, R.N.V.R., O.B.E., R.O.I., R.I., "Naval Camouflage."

BRIGADIER-GENERAL LORD MONTAGU OF BEAULIEU, C.S.I., "Motor Transport in India."

SIR GEORGE CUNNINGHAM BUCHANAN, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

SIR JOHN HUBERT MARSHALL, C.I.E., M.A., Litt.D., F.S.A., Director-General of Archæology in India, "Recent Archæological Discoveries in India."

SIR VALENTINE CHIROL. (Sir George Birdwood Memorial Lecture.)

SIR FRANCIS WATTS, K.C.M.G., D.Sc., Imperial Commissioner of Agriculture for the West Indies, "Tropical Departments of Agriculture, with special reference to the West Indies." LIEUT.-COLONEL SIR DAVID PRAIN, C.M.G., C.I.E., LL.D., F.R.S., Director of the Royal Botanic Gardens, Kew, will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m.:—

January 15, February 19, March 18, April 15, May 20.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

February 3, March 2, May 4.

CANTOR LECTURES.

Monday evenings, at 8 p.m.:—

JOHN THEODORE HEWITT, M.A., D.Sc., Ph.D., F.R.S., Emeritus Professor of Chemistry, East London College, "Synthetic Drugs." Three Lectures.

Syllabus.

LECTURE I.—DECEMBER 1.—Introductory—Simple aliphatic compounds—Alcohols, formaldehyde, paraldehyde—Ketones and derivatives such as sulphonal—Veronal and other compounds derived from urea—Non-aromatic cyclic compounds, *e.g.* the derivatives of Borneol.

LECTURE II.—DECEMBER 8.—Phenol, salicylic acid and related substances—Derivatives of aromatic amines and aminophenols, *e.g.* phenacetin—Compounds of heterocyclic structure, antipyrine, flavine, etc.

LECTURE III.—DECEMBER 15.—Modified alkaloids, *e.g.* heroin, euquinine—Organic compounds of arsenic (atoxyl, salvarsan), antimony mercury and other metals—Conclusion.

CAPTAIN H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S., Fellow of Downing College, Cambridge, and formerly of the Royal Air Force, "Aircraft Photography in War and Peace." Three Lectures.

January 19, 26, February 2.

CHARLES FREDERICK CROSS, B.Sc., F.R.S., F.C.S., "Recent Research in Cellulose Industry." Three Lectures.

February 16, 23, March 1.

WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758-1837." Three Lectures.

May 3, 10, 17.

JUVENILE LECTURES.

Wednesday afternoons, at 3 p.m.:—

LOUGHNAN PENDRED, M.I.Mech.E., Editor of *The Engineer*, "Railways and Engines."

January 7, 14.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOVEMBER 24...Ingénieurs Civils, Société des (British Section), at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.30 p.m.

Swiney Lectures, Imperial College of Science, South Kensington, S.W., 5.30 p.m. Dr. J. D. Falconer, "The Geology and Mineral Resources of the British Possessions in Africa." (Lecture VII.)

Electrical Engineers, Institution of (North-East Centre), Armstrong College, Newcastle, 7.15 p.m. Mr. W. D. Owen, "Wireless Telegraphy in the Mercantile Marine."

Actuaries, Institute of, Staple Inn Hall, Holborn, W.C., 5 p.m. Dr. C. E. Howell, "The Reversionary (or Prospective) and Collective Methods of Valuing Widows' Funds, with some Notes on the Valuation of Church of Ireland Widows' and Orphans' Fund."

TUESDAY, NOVEMBER 25...Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.30 p.m. 1. Presidential Address on "The Work of Lambert." 2. Exhibition of High Candle-power Lamps and New Developments in Photometry.

Royal Dublin Society, Leinster House, Dublin, 4.15 p.m. 1. Mr. T. G. Mason, "On some Factors affecting Concentration of Electrolytes in the Leaf-sap of *Syringa vulgaris*." 2. Mr. L. B. Smyth, "The Carboniferous Coast Section at Malahide." 3. Mr. J. J. Dowling, "An Apparatus for the Production of High Electrostatic Potentials."

University of London, University College, Gower-street, W.C., 5.30 p.m. Mr. J. H. Helweg, "Holberg and Ewald." (Lecture IV.)

Electrical Engineers, Institution of (North-Midland Centre), Victoria Hotel, Sheffield, 7 p.m. Discussion on "The Use of Electrical Machinery in Goods Stations and Yards."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Mr. H. H. Gordon, "Metropolitan Road and Rail Traffic."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. C. P. Crowther, "'No' and other things Japanese."

Anthropological Institute, 50, Great Russell-street, W.C., 8.15 p.m. Dr. W. Strong, "Some Personal Experiences in British New Guinea."

Colonial Institute, Central Hall, Westminster, S.W., 3.30 p.m. Lieut. E. W. P. Chinnery, "Unknown New Guinea."

WEDNESDAY, NOVEMBER 26...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Dr. H. B. Morse, "British Trade in China."

Aeronautical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. G. Brewer "Some Kite Balloon Experiments."

British Academy, Burlington House, W., 5 p.m. Mr. John Bailey, "Poetry and Commonplace."

Swiney Lectures, Imperial College of Science, South Kensington, S.W., 5.30 p.m. Dr. J. D. Falconer, "The Geology and Mineral Resources of the British Possessions in Africa." (Lecture VIII.)

Oriental Studies, School of, Finsbury-circus, E.C., 5 p.m. Mr. L. Binyon, "The Art of Asia. Lecture II.—India."

United Service Institution, Whitehall, S.W., 3 p.m. Major-General Sir G. Aston, "Combined Operations."

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Dr. N. Raw, "Housing in Relation to Tuberculosis and other Infectious Diseases."

University of London, University College, Gower-street, W.C., 3 p.m. Mr. E. G. Gardner, "History and Drama in the Divina Commedia." (Lecture VI.) 5.30 p.m. Mr. H. E. Palmer, "Methods of Learning Foreign Languages." (Lecture IV.) Mr. I. C. Gröndahl, "Holberg and Wessel." (Lecture IV.) 6.15 p.m. Mr. J. C. Stamp, "Fundamental Principles of Taxation in the Light of Modern Developments." (Lecture IV.)

THURSDAY, NOVEMBER 27 ... Cold Storage and Ice Associations, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m.

Royal Society, Burlington House, W., 4.30 p.m.

University of London, University College, Gower-street, W.C., 5.30 p.m. Professor A. Cippico, "La Poesia di Giovanni-Pascoli." (Lecture V., in Italian.) Mr. I. Bjorkhagen, "Selma Lagerlof." (Lecture IV.)

Auctioneers and Estate Agents Institute, 34, Russell-square, W.C., 7.45 p.m. Sir W. Wells, "The Future of Professional Education."

Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Messrs. C. C. Paterson, J. W. T. Walsh, A. K. Taylor, and W. Barnett, "Carbon Arcs for Searchlights."

China Society, at the School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Professor M. Smith, "Industrial Changes in China."

Mechanical Engineers, Institution of, at the Engineers' Club, Albert-square, Manchester, 7 p.m. Mr. C. G. Conradi, "The Present Position of Mechanical Road Traction."

FRIDAY, NOVEMBER 28...Swiney Lectures, Imperial College of Science, South Kensington, S.W., 5.30 p.m. Dr. J. D. Falconer, "The Geology and Mineral Resources of the British Possessions in Africa." (Lecture VI.)

Engineers and Shipbuilders, North-East Coast Institution of, Westgate-road, Newcastle-on-Tyne, 6.15 p.m. Mr. A. Hogg, "Test of Watertight Bulkheads for Ship Subdivision."

University of London, University College, Gower-street, W.C., 8 p.m. Professor G. D. Hicks, "An Introduction to Modern Philosophical Thinking." (Lecture IV.)

Mechanical Engineers, Institution of, The University, Sheffield, 8 p.m. Mr. C. G. Conradi, "The Present Position of Mechanical Road Traction."

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m. Discussion on Lubrication.

SATURDAY, NOVEMBER 29...National Special Schools Union, at the ROYAL SOCIETY OF ARTS, John-street Adelphi, W.C., 10 a.m.

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FRIDAY, NOVEMBER 28, 1919.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 1st, at 8 p.m. (Cantor Lecture.) JOHN THEODORE HEWITT, M.A., D.Sc., Ph.D., F.R.S., Emeritus Professor of Chemistry, East London College, "Synthetic Drugs." (Lecture I.)

WEDNESDAY, DECEMBER 3rd, at 4.30 p.m. (Ordinary Meeting.) JOHN WESTALL PEARSON, Chairman and Director, British Oil and Cake Mills, "The Oil Seed Crushing Industry." The Right Hon. LORD LAMINGTON, G.C.M.G., G.C.I.E., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

JUVENILE LECTURES.

The usual short course of lectures adapted to a juvenile audience will be delivered on Wednesday afternoons, January 7th and 14th, 1920, at 3 p.m., by Mr. LOUGHNAN PENDRED, M.I.Mech.E., Editor of *The Engineer*, on "Railways and Engines."

Special tickets are required for these lectures. They can be obtained on application to the Secretary.

A sufficient number of tickets to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each Fellow is entitled to a ticket admitting two children and one adult. Fellows who desire tickets are requested to apply for them at once.

PROCEEDINGS OF THE SOCIETY.

SECOND ORDINARY MEETING.

Wednesday, November 26th, 1919; BYRON BRENAN, C.M.G., late H.B.M. Consul-General, Shanghai, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Brocklebank, Captain H. Cyril R., R.N., O.B.E., Tarporley, Cheshire.
Croft, Albert John, Birmingham.
Dunning, Harold Frederick, London.
Grant, Gustavus John, Birmingham.
Mercer, Raymond G., Manchester.
Paxman, Edward Philip, Bournemouth.
Plant, A. Edmund, Poulton-le-fylde, Lancs.
Reed, T. A. Woolterton, London.
Saunders, Arthur D., Bexhill-on-Sea.
Skelley, Horatio Arthur, Hyde, Cheshire.

The paper read was—

BRITISH TRADE IN CHINA.

By H. B. MORSE, LL.D.,
Late Statistical Secretary, Inspectorate-General of Chinese Customs.

My subject is narrower than my title. I propose to-day to treat only of English trade—the trade of the United Kingdom; and I shall refer to British trade—the trade of the British Empire—only in so far as it affects English trade. In fact, during the first phase of the trade, from 1637 to 1833, a broad distinction must be made between two branches: the monopoly trade of the English East India Company between London and Canton, and the "country" trade between Canton and ports east of the Cape of Good Hope, open under licence to all British subjects, whether they belonged to London or Glasgow, to Calcutta or Bombay.

I must also take note of another limitation on my title: I shall not prescribe dogmatically for the future. I stand here as the theorist, the economist, the statistician, addressing a gathering of practical men—administrators, industrialists, merchants—and my words will be of use to you only in so far as I stand on a foundation of historical fact. When I try to look into the future I am confronted by the warning of the wise man, who bade us "never prophesy unless you know." What I can do

for you, however, is to give you an account of the past and the present; and if I can construct a curve connecting that past with the present, it will be for you, with your practical knowledge, to project the curve into the future, making due allowance for disturbing factors which might deflect the curve upward or downward.

England was relatively late in entering the China field—even in those days she needed a leader to urge her to "Wake up, England!" She had been preceded first by Portugal, whose people were the bold explorers, navigators, and oceanic traders of the fifteenth and sixteenth centuries. They established themselves in India and in the Spice Islands, making Lisbon for a time the prosperous rival of Venice and Genoa as a mart for distributing the silks, spices, and other luxuries of the Far East. In 1511 they took Malacca, the entrepot on the gateway to the Farther East, and in 1517 their first ships arrived at Canton. The Spanish arrived in 1575, coming from the West, from America and the Philippines; but they took no active part in the trade, and for a century the Portuguese had it to themselves, acting as the sole intermediaries in bringing Chinese produce by sea to the European markets. Success and prosperity encouraged the buccaneering instinct which characterised all European nations in the sixteenth century, and the Chinese Government found it expedient to suppress the factories along the coast, as far north as Ningpo at the mouth of the Yangtze, burning the ships, killing hundreds of Portuguese, and slaughtering thousands of their Chinese adherents. In 1557 they were allowed to settle on the barren peninsula of Macao, and there for three centuries, under Chinese jurisdiction—territorial, judicial, and fiscal—they provided the threshold by which European traders obtained access to the Chinese market.

The men of the free Netherlands came next—the men of Rotterdam and Amsterdam, but not those of Antwerp and Ostend; men who made a world-wide trade, even with their enemy, support their hundred years' war with Spain. The refrain of the old song tells us that—

> "Nutmegs and ginger, cinnamon and cloves,
> Oh, they gave me this jolly red nose;"

but, together with pepper and sugar, they also provided a flavouring for the otherwise flavourless diet of Mediaeval and Renaissance Europe, and they came to Europe from the East. The routes developed by Venice and Genoa had been blocked by the Turkish occupation of Trebizond, Constantinople, Alexandria, and the Levant generally, and Lisbon had become the primary port of entry of Asiatic spices into Europe. The annexation of Portugal by Spain in 1580 made it uncomfortable for the Dutch to frequent the market-place of Lisbon; and, after thinking it over in the leisurely way characteristic of the time, they sent out a strong fleet to Eastern waters. In the years 1604 to 1610, with this fleet, by the occupation of Amboyna, Java, and other islands, formerly Portuguese, they laid the foundation of the Dutch colonial empire, and solved radically the problem of obtaining spices for their table and their trade. In 1604 they attempted to trade at Canton, but the attempt was frustrated by Portuguese jealousy; in 1622 a fleet of fifteen ships attacked Macao, but was beaten off with heavy loss; in 1624 they occupied Formosa, then a no-man's land, but were driven out in 1662. Thereafter they traded at Amoy, and obtained access to Canton only in 1685, when the enlightened Emperor Kanghi threw open the trade to all nations.

It was more than a hundred years after the arrival of the Portuguese that, in 1637, the first English ships came to Canton, and nearly another hundred years elapsed before England began to rub her eyes and wake up—one ship in 1664, one in 1674, these two to Canton; one in 1670, one in 1677, these to Amoy; four ships in forty years, but thereafter about one a year, mostly to Amoy. About 1700 the English East India Company began to send sporadic ships, more or less every year, to Canton; and in 1715 it established a permanent factory at Canton, carrying on from year to year, and no longer treating each ship as a separate transaction.

The French sent their first ship to Canton in 1660, and established their factory there in 1728. They were followed by others of the European States, and before the end of the eighteenth century every flag of Western Europe was represented. A very few ships, such as those of Hamburg, Bremen, Lübeck, and an occasional ship from an Italian state, came without governmental encouragement, support or control; and the Portuguese, content with their position at Macao, seem not to have subjected their trade at Canton to official control; but, generally speaking, the ships and trade of each nation were under the absolute monopolistic control of the East India Company of that nation—English, Dutch, French, Prussian, Imperial (Ostend), Danish, Swedish. England was at last awake in a somnolent eighteenth-centuryish way, and her trade

became very soon the dominant element in the Canton factories.

More latitude, more relaxation from the strict monopoly, was granted to British merchants than to those of other nationalities. The East India Company continued to arrogate to itself the sole right to trade, both inwards and outwards, between Canton and England—in fact, between Canton and all ports west of the Cape of Good Hope; but it granted to British merchants, not only the English but also the Parsees, Jews, Bengalis and others of Calcutta, Bombay, Madras and other ports, licences to engage in the "country" trade between Canton and ports east of the Cape of Good Hope. Apart from this relaxation, close monopoly was the rule on both sides, for foreigners and for Chinese.

Into this world of monopoly came the intrusive free-trading Americans in 1784, the first year in which an American ship under the American flag could cross the ocean in comparative safety. Their merchants were as intelligent and as keen, their sailors as hardy and as enterprising, as those of the stock from which they sprang. In 1788 the ship "Alliance" sailed with no charts of eastern waters on board except the maps on Mercator's projection in a school-atlas, and did not drop anchor during the whole of her voyage from Philadelphia to Canton; and American merchants and supercargoes supplied just that spur of competition and co-operation on an equal footing which is all that the English needed—in those days—to bring out all that was best in them.

There were no statistics of trade in those days; all transactions were veiled in mystery. Of this I will give one illustration. The only mail carriers were the trading ships, and these carried cargo, inwards and outwards, each for only one merchant. When, after a voyage of five months, letters arrived to any other address than that of the consignee of the ship, they were interned during the stay of the ship, perhaps three months, for fear lest they should contain commercial intelligence of value to competing firms; and were delivered to the addressees *after* the departure of the ship which brought them. I have, however, collected a few scattered notes, which have a certain value since, in the eighteenth century, British ships invariably brought goods consigned to a British merchant, and carried away produce shipped by a British merchant; and so with all other flags.

In 1751, Osbeck, a Swedish scholar, notes that, on arriving at Whampoa (the anchorage for Canton) he found there 9 English ships, 4 Dutch, 1 Danish, and 2 Swedish, a total of 18; as the British included those of the East India Company, huge leviathans of 800 to 1,200 tons burthen, while other ships would be between 300 and 500 tons, the English tonnage was three-fifths of the total. His ship, of the Swedish East India Company, was 9 months and 11 days on the voyage out (2 months and 16 days spent at Cadiz), stayed 4 months and 10 days at Whampoa; and arrived at Gothenburg after a voyage of 5 months and 22 days, with thanks to God for the safe return of the 124 men on board. Except for a few tons of lead, she provided for her outward cargo by carrying silver dollars. Her outward lading from Canton was as follows: 1,232,187 lb. of tea; 5,047 lb. of raw silk; 4,055 pieces of silk stuffs; 5,319 pieces of cotton stuffs (Nankeens); 4,171 lb. of rhubarb; 1,263 packages of porcelain; 2,250 lb. of mother-of-pearl; 6,325 lb. of rattans; 35,314 lb. of galangal root; and 6,359 lb. of China-root.

Forty years later, in 1789, there was a total of 86 ships—61 British (21 Company, 40 country ships), 15 American, 5 Dutch, 1 French, 1 Danish, and 3 Portuguese. The British, in the same proportion of tonnage, had now 75 per cent., and the Americans, in the sixth year of their trade, 14 per cent. From this time the French Revolution and the subsequent wars drove the other flags away for twenty-five years, and left the trade entirely to the English and (except in the years 1813–1815) to the Americans, who shared it roughly in the proportion of three to one. This predominance the two nations never lost in the Canton factory days, even after the re-establishment of peace allowed the other nations to return. In the sixteen years, 1818 to 1833, the Dutch trade averaged 7 vessels in each year, of a total of 1,520 lasts (about 2,660 modern tons register), carrying imports averaging 498,950 dollars, and exports of an annual value of 468,330 dollars. No other Continental country exceeded about 100,000 dollars for imports and the same for exports. In those same years the American trade averaged 37 ships of 13,209 tons burthen (about 14,640 tons register); imports averaged 2,469,599 dollars in goods and 3,630,586 dollars in specie; exports averaged 6,453,492 dollars in goods, besides about 260,600 dollars a year disbursed for the shipping. The British trade was 56 a year (about two-fifths Company ships) of a total tonnage which I estimate between 60,000 and 70,000 tons. The imports averaged 18,765,319 dollars in goods, with only occasional lots of

specie (English products about 3 million dollars, Indian opium 6½ million, Indian cotton 4 million, other Asiatic produce 5 million). Exports averaged 13,100,000 dollars in goods and 3,500,000 dollars in specie (tea 7¾ million, silk and other products 5¼ million), besides about 450,000 dollars disbursed for the shipping. Of the export trade of those years we may say that 63 per cent. was British, 32 per cent. American, 2½ per cent. Dutch, and 2½ per cent. was divided between the other flags.

Thus, then, in 1833 the British flag had over three-fifths of the trade of Canton (which was China), the American a third, and the other flags "also ran"; and in those days the flag-trade meant national trade, and every ship carried goods, in or out, only for the merchant of her own nationality to whom she was consigned. Your attention will, however, be attracted to the small proportion of English manufactures (about 15 per cent.) entering into the British trade, and this small proportion was contributed by Leeds and Bradford, and not by Manchester; in those days cotton woven fabrics were shipped from Canton to London, and not from England to Canton.

The British trade was, broadly speaking, conducted on a triangular basis. The East India Company shipped English goods to Bombay and Calcutta, and, to the extent of that 15 per cent., to Canton; on this last item the Directors informed a committee of the House of Lords in 1820 that their net loss on English products in twenty-three years had been £1,688,103. Then country merchants (English and Indian) under licence shipped cotton and opium from India, and spices and other tropical products from the Southern Isles to Canton. Then, on the third leg of the triangle, Canton sent tea and silk, together with drug products and Chinese curiosities, to England, and, after about 1815, specie to India.

The American trade was, also broadly speaking, conducted on a triangular basis. Some ships carried American produce (flour, salted fish, etc) to Europe; then they engaged in the coasting trade as neutrals in a world of war; and then they sailed with a "cargo" of Spanish dollars for Canton, picking up on the way, perhaps, such goods as seemed to their supercargo to have a speculative value. Other ships loaded axes and beads, and in the South Pacific cut a cargo of sandalwood, which they carried to Canton. Others again carried supplies to the Spanish colonies on the Pacific coast, then bought furs at the Columbia and in Oregon, which they carried to Canton. Thence they all took tea, silk and other Chinese products back to their home port.

The problem of the merchant of that day was the dollar—the price at which it could be laid down; for the Chinese would take no other specie than the silver dollar, and that must be a Spanish dollar, and in the first half of the nineteenth century it must bo of the mintage of Charles IV. (1788-1808). At the outset Europe had few goods to send—few that the Chinese wanted, and every ship had to take what silver was required to buy a cargo of tea and silk. In 1683 the Directors of the English East India Company wrote referring to "the loss of Bantam to the Dutch, and the "Johanna" outward bound to your place (Amoy) with her stock of £70,000, most bullion." The necessity increased through the eighteenth century; and in the century and a third to 1833 I estimate that, on net balance, not less than five hundred million dollars in silver coin were imported into Canton and stayed there. The Napoleonic wars created a great demand for the same coin, and we know that Wellington was often at his wit's end to obtain dollars in competition with the demand for China, while, in their turn, the China traders had to buy dollars at much above their intrinsic value. In normal times there is no way of laying down the dollar so expensive as that of sending the actual coin over 15,000 miles of ocean, with five to seven months' demurrage for the ship; and the merchants were driven to discover some fertilising stream of goods to provide the funds for buying outward cargoes, for maintaining their establishments at Canton, for the disbursements on the ships, and to meet the Chinese exactions on their goods and their ships. Europe and America could send little the Chinese would buy, and yet the traders could not maintain their infertile stream of dollars.

The English traders were the first to extricate themselves. While the Chinese would not take a larger quantity of English products, it was found that they would take two Indian products — cotton and opium. Cotton, in quality superior to the Indian, is produced in the whole of the Yangtze basin of China (export in 1918 to Japan, 1,292,094 piculs = 431,000 bales); but, so exacting was the demand for goods to import, a large trade grew up in Indian cotton, its value in the years 1818 to 1833 being always greater than that of all English products, and in many of the years

being twice as great; its value exceeded that of opium until 1822, after which opium passed it. Opium was a prohibited article, which the Chinese bought freely; but, being prohibited, sales were always for cash, and opium was found to be so convenient a form of remittance that its imports increased rapidly, under 2 million dollars in 1818, to 4 million in 1823, to 10 million in 1829, and 12 million in 1833, in which year Indian cotton was 5½ million and English manufactures 2½ million. The English trade was now on a sound basis economically (I am not dealing with the moral aspect), and English ships ceased to bring specie from about 1815 except occasionally (3 million dollars in 1820, 1 million in 1824). From 1818 the English trade began to export specie between 2 and 4 millions a year to 1827, after that between 4 and 6 million a year, sent from Canton to Calcutta.

The American traders were longer in finding relief. Their own country supplied almost nothing that the Chinese wanted; they picked up what they could on the way; they carried Turkey opium from Smyrna, sometimes bought in London—a trade prohibited to the English traders; they arranged with English firms to receive Indian opium on consignment; but from first to last the specie imported in American ships constituted a much larger proportion of the lading than that of British ships. From 1818 to 1826 the specie was never less than twice, and was often more than thrice, the value of the goods on board. In those nine years American ships imported 49 million dollars, and British ships exported 19 million. In 1827 the Americans began to take bills on London as a means of remittance to Canton; these bills were bought there by the British merchants (English and Indian), and by them sent to Calcutta and Bombay. In the seven years 1827 to 1833 American ships imported no more than 8¼ million dollars, while British ships exported to India 36¼ million. The American trade sold London bills in Canton to the extent of 2½ million dollars in 1832 and 4¾ million in 1833.

I have said that, except for the Americans, the trade was under the strict control of a monopoly on both sides. Of the Chinese monopoly I shall say little; it would take too much of my space and of your time. One phase of it I may mention, however. Every foreign trader had to select a member of the Chinese Gild as his "security" merchant. He rented office and living accommodation to the foreigner, engaged his cashiers and servants, and "secured" them; to him alone the foreigner could sell his imports (opium excepted); from him alone could tea and silk and other exports be bought; and he was held responsible for every act connected with the foreign trader and his ships, from the purchase of a basket of fruit to homicide. *Per contra* the foreigner paid no customs duties; the security merchant paid them all, the regular and the irregular, the legal and the extortionate. Only on his ship did the foreign trader pay directly the exactions, amounting to 10 dollars, about £2, a ton and even more. Close restriction was the rule, and yet no one was dissatisfied. The Chinese officials were satisfied, as they made vast fortunes from the trade, more even from the prohibited opium than from the legal trade. (The Hoppo in one year accounted for a reported collection of 899,000 taels = 1,200,000 dollars. In that year I estimate that his gross collection from the trade, foreign and native, under his jurisdiction was not less than 13,000,000 dollars.) The Chinese merchants were unmercifully squeezed, but, *per contra*, they were backed by the full power of the government to milk the trade to its fullest capacity; and those who did not go bankrupt made huge fortunes. (Howqua in 1834 estimated the value of his own estate at 26,000,000 dollars.) The foreign traders made such profits as their Chinese friends allowed them to make; but their distant exile and their expert knowledge could not go unrewarded, and they were usually able to bring home a plum or two. On the whole, however, the situation is best summed up in Burke's comparison in 1783 of the Chinese monopoly with that of the English East India Company—"As the Chinese monopoly is at home, and supported by the country magistrates, it is plain it is the Chinese company, not the English, which must prescribe the terms." It was the Chinese Gild which prescribed the terms, and those terms were accepted by the foreign traders; they grumbled, of course—even the Americans were infected and grumbled; but the only serious note of protest was that of the English merchants against the monopoly of their own English company. They contrasted the restraints imposed on them with the freedom enjoyed by their only rivals, the Americans; and, supported by the Chambers of Commerce in England, they clamoured for the abolition of the monopoly of trade between England and China enjoyed by the East India Company. The monopoly was abolished and the trade thrown open from April 22nd, 1834.

The English in Canton were now a headless community, subject only to the nominal control of His Majesty's Chief Superintendent of Trade, and they found that, on the Chinese side, they had gained nothing, when, naturally and nationally individualistic, they were brought face to face with the close combination of the Chinese Gild, which was still "supported by the country magistrates." Five uncomfortable years followed, and then began the Opium War. The Chinese called it that, and that is what they will always call it; to them opium was the sole cause of the war. But in the settlement imposed on China, by force of arms, opium was not mentioned; Lord Palmerston's instructions were that it was open to the Chinese to prohibit the trade if they would, and suppress it if they could. The actual British claims were not admitted by China as negotiable, they were preposterous; but in the treaty they were the points that were settled—the equal national status of the United Kingdom and China, the right to appoint official consuls and not mere trading headmen, privilege of trading at five ports, abolition of (Chinese) monopoly, publication of a fixed customs tariff, jurisdiction over British subjects under criminal charges.

This was the first phase of the China trade, ending nominally in 1834, actually in 1842. It was a period of slow communications, when foresight and intelligent thought were required of the merchant, and when supplies were ordered for a future market and not to meet an existing demand. The ship which brought the goods brought also the merchants' advices; and in 1839, at a critical time when speed was imperative, important despatches from Captain Elliot took from five to seven months from Canton to London. Just as the phase was passing steam communication was introduced by the "overland route" across the Isthmus of Suez, and mails came at what seemed to the traders lightning speed. In 1841 Sir Henry Pottinger left London on June 5th, and after spending ten days at Bombay, arrived at Macao on August 10th—making sixty-six days; but he was a plenipotentiary hastening to his post. In 1844 the average time taken by the thirteen monthly mails from London to Hong Kong was eighty-four days; in 1859 this had been reduced to fifty days.

My second phase I take as ending in 1867, a date fixed with reference to the following events: end of the state of conflict between China and the West in 1860; suppression of the Taiping rebellion in 1864; world-wide monetary crisis in 1866; opening of the Suez Canal in 1869. It was the period of the fast-sailing tea clipper, when the merchant's goods went by sailing ship and his advices by steamer; but the telegraph cable reached Shanghai only in 1871. Foresight was still required and reaped its proper reward; but the merchant could now partially correct his errors of judgment, through having speedier mail communication. On the other hand, it still, prior to the opening of the Suez Canal, took from four to seven months for his goods, imports and exports, to reach their market. The period was one of great disturbances, and of great commercial opportunities—for profit and for loss. Friction between the Chinese government and the Western traders was continuous: but for the Chinese people, while those around Canton were exceedingly hostile—humiliated by defeat and embittered by the loss of their trading monopoly—those at Shanghai were most friendly. Rebellion spread over the whole empire, disturbing trade and disorganising the administration; as a consequence the officials, already corrupt by our Western standards, became more forth-putting in their corruption; and as a consequence of this the smuggling of opium was widespread, and assumed great proportions. This provided larger funds for a very much larger export trade —for the Chinese did not yet demand great quantities of European products. At the opening of the second phase Manchester was just beginning to send cotton fabrics to China, and England was just ceasing to take Chinese nankeens; through the phase Leeds continued to send woollens, but the demand did not greatly increase; and ships continued to take flints to light the Chinese fires and pipes.

During this phase, with friction constant between Chinese and British officials, the British Navy was doing the work of the Chinese government in suppressing piracy along the coast—was doing it even while England and China were at war; the British authorities at Hong Kong were giving the protection of the British flag to Chinese-owned shipping with the consent, and with the gratitude, of the Chinese authorities; the British, American, and French consulates were giving similar protection at Shanghai; and the situation was so anomalous that, on the same days, August 18th to 20th, 1860, the allied British and French troops were assaulting the imperial forts at Taku, while other British and French troops were defending the imperial city of Shanghai from an assault by the Taiping rebels. The period

was punctuated by two wars between England and France in alliance against China, one in 1856–58, the other in 1860.

But the dominating feature was the fact that, from 1842, there was a known moderate, published customs tariff in force; and that the foreigner paid his own duties as a tax and not as a part of the cost price, or a deduction from the price realised. Moreover, he had secured a reduction in the port charges on his ships from about ten dollars a ton to half a tael (two-thirds of a dollar) a ton. These facilities, together with the opening of five ports, the abolition of monopoly, and an appearance of protection to their trade, brought in by degrees numbers of competitors from the nations less adventurous than the English and Americans; but for some years the effect of this was not very marked.

The end of the first phase left the English and Americans in a predominating position at Canton; between them they had 95 per cent. of the trade, the English 63 and the Americans 32 per cent. In shipping, the Americans in the second phase took hold vigorously, and they originated a carrying trade. It had been the custom for ships to bring only goods for, and to carry only goods shipped by, their consignee; but the Americans began to load cargoes for the merchants generally. At the same time they improved their ships. The old East-Indiamen furnished the type of the British ships, even those of smaller size—bluff in the bow, heavy in the stern, good weight-carriers, splendidly seaworthy, but slow. The Americans improved on this, and invented the tea-clipper. In 1852, at Shanghai—which was already forging ahead of Canton—of the shipping entered, the British were 103 of 38,420 tons (average 375), the Americans 66 of 36,532 tons (average 553), and all other flags 13 of 3,213 tons. But the English had already, two years before, thrown away the crutches of their Navigation Laws, and without hesitation they accepted the challenge. In 1855 British shipping at Shanghai was 75,131 tons, American 56,792 tons, and all other flags 22,9.7 tons. In 1846, at Canton, the shipping entered was—British 88,880 tons, American 29,688, and all other flags 5,737 tons. In 1864 the shipping entered and cleared at all ports of China had a tonnage of 6,635,485 tons, of which the British was 2,862 214 tons, the American 2,609,390 tons, the several German states (Bremen, Hamburg, Hanover, Lübeck, Mecklenburg, Oldenburg, and Prusssia) together 580,570 tons, and all other flags 583,811 tons. These figures are startling; we have jumped at once from tens of thousands into millions. But the earlier figures give the tonnage of ships entered only, while in the later figures the tonnage entered is added to the tonnage cleared; the later figures should therefore be reduced to about a half for comparison. The ratio between British and American tonnage is still unaltered, and the several German flags assume respectable proportions. I have taken 1864 instead of 1867 in order that the German figures might refer to a time before the foundation of the North-German Federation, and so to give point to a quotation from Michie in his "Englishman in China":—

"Such a mosquito fleet was, perhaps, never before seen as that which flew the flags of the Hanse Towns and of Scandinavia on the China coast between 1850 and 1860; and many a frugal family on the Elbe, the Weser, and the Baltic, lived and throve on the earnings of these admirably-managed and well-equipped vessels ... the ships were run on a scale of economy and efficiency scarcely then dreamed of in England."

Herein lies the secret of this jump into millions; the foreigner had injected his shipping into the coasting trade, including the navigable rivers. The Chinese authorities considered that this trade should be reserved for Chinese shipping. While foreign ships were making their first intrusion into the Chinese coasting trade, the English law restricted the coasting trade of the United Kingdom to the British flag; and to this day American and Russian law reserves their own coasting trade, even for voyages from New York to San Francisco and from Odessa to Vladivostock, to their own flags. But the logic of events was too strong for the Chinese authorities. Foreign ships alone offered a speedy, safe, and insurable means of transport, they alone could protect their cargoes from pirates and rebels, and their services were everywhere in demand. For the long ocean voyage a sailing ship entered a Chinese port once a year; in the coasting trade, she entered a dozen or a score of times a year; and a steamer might enter from one to three hundred times, swelling the tables by her tonnage on each entry. In this trade the English and Americans both shared; and the Germans, with as yet inconsiderable trade in goods of their own, swarmed along the coast in brigs and barques of an average of 200 to 300 tons, the British average being 360 tons and the American 520 tons. The true significance of the shipping tables is seen when we compare the proportion of foreign tonnage engaged in foreign trade with that in the coasting trade;

but it must be noted that Hong Kong, a port of the Chinese commercial area, is necessarily treated as a foreign port. Taking the figures for 1872, the proportions were—

British—Foreign trade, 33 per cent.; coasting trade, 67 per cent.

American—Foreign trade, 6 per cent.; coasting trade, 94 per cent.

German—Foreign trade, 27 per cent.; coasting trade, 73 per cent.

Of the tonnage engaged in foreign trade, British was 70 per cent., American 11, German 9.

Of the foreign tonnage engaged in the coasting trade, British was 40 per cent., American 49, German 7.

But the peculiar status of Hong Kong unduly increases the figure for the British share in the foreign trade, and correspondingly reduces the British share in the coasting trade; still it is obvious that the English merchants were drowsy in developing their share in the coasting trade.

I will return later to the development of the trade in goods during the second phase, only dealing briefly with it here. The original purpose of the foreign traders in coming to China was to obtain tea and silk, and the import of foreign goods was only a secondary object, to provide the means of purchasing outward cargoes. I will therefore deal with the export trade first.

In *tea* China had a monopoly of supplying Western markets, practically through the whole of the second phase. At the end of the phase, in 1867, Japan and India together supplied 10 per cent. and China 90 per cent., but up to 1850 China supplied the whole. Of the total export, by sea and by land frontier, in 1828 and 1867 the distribution was as follows—

	1828. lb.	1867. lb.
United Kingdom . . .	27,301,790	134,999,100
English Channel for orders	...	10,497,600
Hong Kong	...	13,905,900
Russia	25,200,000	28,724,800
Continent of Europe . .	5,384,497	80,400
United States	6,875,676	25,887,100
Australasia, India, and Canada	2,441,794	16,982,000
	67,203,757	231,076,900

The table is significant. China was selling three and a half times as much tea. England and America were taking five times as much. Holland and the Hanseatic towns were taking practically none. Why? Because the English tax on tea had been reduced from its old rate of 96 per cent. to a shilling a pound, and smuggling was no longer profitable; and, in consequence, the English merchant supplied the whole of his natural market.

Raw silk, under the last years of the days of monopoly, had never exceeded 616,000 lb., but during the first three years after the English monopoly had been removed, rose to an average of 1,400,000 lb. a year. Then the Chinese monopoly was removed, and Shanghai, the natural outlet of the principal silk district, was opened to foreign trade; and in 1852 the export was 3,575,000 lb. Then the Taiping rebellion spread over the empire, cutting off the home demand for luxury products, and the supply increased until in 1858, in the midst of the war between China and England, the export was 9,628,600 lb.; and even in 1867, a year of depressed trade, it amounted to 5,040,000 lb., in addition to shipments of 504,000 lb. of woven silk.

In 1867 tea and silk of all kinds were valued at 53,408,400 taels; all other exports to foreign countries (including Hong Kong) were valued at 4,397,313 taels, making a total of 57,805,713 taels.

We have now to consider the method by which those exports were paid for. First in importance comes opium. The quantity known to have entered into Chinese consumption in 1867 was 86,530 piculs (103,000 cwt.), valued at 44,018,076 taels, which was the highest figure up to that date.

The next item is cottons, with the surprisingly high value of 14,617,268 taels. The end of our first phase left England receiving cotton cloth (nankeens) from China; in this second phase Manchester has been finding outlets for her products, and is now sending a few shiploads to supply China's millions. In the main, however, China still clothes her own people with her own cotton; and she even continues to import raw cotton from India, 336,072 piculs in 1867, valued at 5,164,392 taels, over a third of the value of English cotton cloth.

In the first phase the principal import from England was woollens, the value being about two million dollars ($1\frac{1}{3}$ million taels). At the end of the second phase this had increased to 7,391,226 taels, which represented the crest of a wave of expansion. Metals are unimportant: lead, 3,440 tons, for packing the exported tea; tin, 1,900 tons, for making brass; copper in bars and sheets, 1,335,000 lb., China herself supplying crude copper; quicksilver from California, 488,800 lb., for making vermilion and backing mirrors; iron and steel,

the gauge of modern civilisation, 7,000 tons. Besides raw cotton and foreign coal (113,430 tons), among "sundries" of sufficient importance to be enumerated, we find flints, ginseng, matches, needles, and window glass, total value 537,113 taels, as the only commodities imported from Europe or America. Other sundries are from the Southern Isles, or are Chinese produce passing through Hong Kong. The total value of all imports was 81,353,241 taels.

I will deal at the end of the third phase with the distribution of trade during the second phase; here I will deal only with the balance of trade. First I must note that the values given above are market values in the Chinese ports, and that, to reduce them to the one common denomination of value at moment of shipping and landing respectively, we must deduct from the value of imports the customs duty and charges estimated at 7 per cent., and must add to the value of exports the customs duty and 8 per cent. for charges. Corrected thus the values are—

Exports, 66,352,613 taels. Imports, 72,501,069 taels. Imports exceeded exports in 1867 by 6,148,456 taels. I shall deal with the balance of trade later.

In dealing with the first phase I went fully into the import of specie, and showed that, at its end, the trade had found the means of paying for the exports by imports, and had ceased to import silver; but meantime, through the whole of the phase, there had been a continuous monetary crisis, in the problem of "laying down the dollar" required for buying export cargoes. The second phase also had its monetary crisis, but it was of shorter duration, lasting from 1853 to 1857. On March 19th, 1853, the city of Nanking, a former capital of the empire, fell to the Taiping rebels. This destroyed 50,000 silk looms weaving industriously in that city; and the spreading success of the rebel armies reduced the whole of China to such a state of destitution as to destroy the demand for a luxury worn only by those who no longer possessed the means of buying it. Raw silk was thrown on the foreign market, and shipments from Shanghai, which had in 1852 reached the very high figure of 41,293 bales, amounted in 1853 to 58,319 bales, and continued to increase until, in 1858, they were 85,970 bales, valued at 29 million dollars (market price). Concurrently with this the demand for foreign products fell off; cotton and woollen fabrics (mostly English), which in 1867 were to be imported to the value of 30 million dollars, amounted in 1858 to no more than 9 million dollars; other commodities, too, were in reduced demand—except opium, which the Chinese would always take. In that year the adjusted value of all exports at Shanghai was about 50 million dollars, and of imports—for opium 15 million, other commodities 19 million, total 34 million dollars; leaving a deficit of 16 million to be covered, besides the cost of maintaining the shipping and the merchant's establishments. Nor was this all. In times of stress the natural instinct of the Asiatic is to hoard—to dig a hole in his back garden and bury in it his metallic treasure; and when the dollars disbursed for silk and tea once came into Chinese hands they were hoarded and no longer returned to the channels of trade. The stringency was extreme. The foreign traders scrambled for every Carolus dollar that they could lay their hands on in every market of the world; Europe was scraped for dollars until it was scraped dry; dollars were poured into Shanghai—a million a month at first, ultimately 20½ millions in 1856, and 18 millions in 1857—but they disappeared into the void as a stream of water is sucked into the thirsty sands of a desert.

The Carolus dollar had an intrinsic value of 4*s.* 2*d.*, but for buying exchange its normal value was from 4*s.* 6*d.* to 4*s.* 10*d.*, the difference representing the cost, including interest, of carrying them to Shanghai. In 1852 the current rate for six-months' bills on London did not exceed 4*s.* 8*d.*, which was 12 per cent. premium over the intrinsic value, until the end of the year, when it rose to 22 per cent. After the fall of Nanking it rose rapidly, until before the end of September, 1853, it was at no less than 86 per cent. premium. It fell again, but never below 50 per cent. premium, and oscillated between 50 and 65 per cent. premium for three years, until in 1856, for shipping the tea and silk of that year, the rate rose again to 86 per cent. premium. The situation became intolerable, and, in the end, the foreign traders in Shanghai were driven to abandon their standard of currency which was represented by a coin, the dollar, and for it to substitute a standard of Chinese currency which was represented by no coin, but only by ounces (taels) of silver. The anomalous situation is shown by the fact that, on a designated day in April, 1857, the banks at Shanghai credited their customers with a tael containing 525 grains of fine silver, in exchange for each dollar,

containing 374½ grains, standing to their credit.

The first phase was the period of the lumbering Indiaman, carrying her own mail advices; when the trader had to foresee the demand of the market next year, and to contract this season for his next season's tea. My second phase was the period of the swift sailing tea-clipper, but her advices were now sent by a monthly steamer; indents for imports could now be filled in seven months, and tea and silk were bought on the strength of market advices only sixty to eighty days old. The third phase, that from 1867 to 1911, the end of the Empire, to which I have come, was the period of the Suez Canal; the period in which the trans-oceanic trade was carried by steamer; with market quotations and orders sent by the cable, which was opened through to Shanghai in 1871; and with the merchant no longer needing long foresight, no longer depending on his sagacity in providing for a distant future, but taking orders to buy or sell, and executing them on commission. Each of the three phases was characterised by its own money difficulty; and, before proceeding to analyse the trade of the third phase, I will describe its currency problem.

The currency of China is the tael, or Chinese ounce, of silver; but there are in China hundreds of different taels, varying according to different weights of the tael and different standards of silver. The first traders traded, and bought exchange, in Spanish dollars. In 1857, as I have just said, the foreign traders at Shanghai adopted the tael as their currency; but those in South China continued to buy and sell goods and bills for dollars—at first Mexican, but afterwards of some other mints—but always by weight and not by count, and always rated by the intrinsic value of the silver content. The course of exchange was therefore affected by two factors: the supply and demand for bills to be negotiated, as in all exchange markets; and, for exchange between China and gold-using countries, the quotation for silver in terms of gold.

Originally all countries based their currency on silver, and this continued for many centuries. Early in the nineteenth century—only one hundred years ago—England abandoned silver and based her exchanges solely on gold. She was only one among the many nations, and her demonetisation of silver did not serve to create any serious alteration in the relative market values of silver and gold; but in 1873 the brand-new German Empire, adopting a brand-new currency, based it solely on gold, and in the same year the United States, partly through inadvertence, also demonetised silver. The sensitive bullion market felt the disturbing influence at once, and the political financiers hastened to get under cover from the threatening storm; by the end of the century, 1900, every commercial nation had adopted either the gold standard or the limping standard—every one except China.

In 1873 the exchange value of Chinese currency began to fall, and (taking 6*s*. 8*d*. per customs tael as par, or 100 per cent.) by 1879 it had fallen to 84 per cent. In 1885 a further fall began, and in 1889 the exchange value was only 71 per cent. In 1891 the fall became more rapid, and in 1894 the value was only 48 per cent., and the lowest level was reached, at 36 per cent., in 1903. In thirty years the currency of the whole empire had lost close on two-thirds of its international exchange value. But the loss in purchasing power of the tael was not the worst feature, as prices can be adjusted to a depreciated currency. Far worse than this were the frequent fluctuations in the exchange. Taking, for example, the years 1903 and 1904, besides the daily oscillations, there were nine major movements between extreme points, ranging from 2 to 16 per cent., of alternate rise and fall; during the two years the highest point was 30 per cent. greater than the lowest point. The uncertainty turned all trade into gambling. Two months might pass while the merchant's goods were on the steamer, three months between the date of a telegraphed order and the arrival of the goods at their market; and in those two or three months exchange might rise or might fall 10, or 12, or 16 per cent., while the merchant worked on a margin of 1, or 2, or 3 per cent. Even if the importing or exporting merchant, the foreigner, prudently settled his exchange simultaneously with his indent, the gamble was only transferred to the Chinese buyer of his imports, or the holder of his Chinese produce on the foreign market. To make matters worse, exchange has recovered, and to-day, in 1919, the silver rate, which in 1903 was at 36 per cent. of its old par value, is again at full 100 per cent.; and this recovery constitutes the exchange problem of the present time.

I should note, as a further complication, that in 1904 silver, the currency of the wholesale trade, had sunk to 68 per cent. of its 1873 value in terms of copper, the currency of the retail

dealer and of the producer and consumer; and further, that the economist and the statistician must deal with the fluctuations in the exchange values of gold, of silver, of copper, and of paper, when dealing with the trade of China. I think I need say nothing more to show the complexity of the subject, and the impossibility of doing anything more than give this outline in a paper on the whole trade of China.

During this third phase, from 1867 to 1911, the shipping engaged in the China trade increased from (entries and clearances) 6,635,485 tons in 1864 (practically no Chinese shipping) to 86,206,497 tons (including 17,277,407 tons of Chinese shipping coming under the foreign customs); the shipping under foreign flags was then 68,929,090 tons, over ten times the figures of 1864. Of the total of 1912, of all flags, 26,071.482 tons were engaged in the foreign trade (including Hong Kong), and 60,135,015 tons in the coasting trade. In the two years the tonnage was divided between the different flags as follows:—

	1864.	1912.
British	2,862,214	38,106,732
American	2,609,390	715,001
German	580,570	6,171,684
Japanese	756	19,913,385
Other foreign	527,967	4,022,288
Chinese	64,588	17,277,407
	6,635,485	86,206,497

In percentage the British flag has held its own, and absolutely has increased to thirteen times its old tonnage. The American flag has disappeared from the coasting trade, and is shown only on a few mail steamers. The German flag fills a space in the table so large as to create a good-sized void to-day. The Japanese have taken the Americans' place as second in the race. And the Chinese are again doing a portion of their own coasting trade, but now in steamers to the extent of three-fourths of the tonnage shown in the table.

We have now to consider the development of the export trade in the third phase.

Tea had a chequered career. Originally the most important element in the export trade. constituting 60 per cent. of the English trade in the first phase, it held its own through the second phase, and, in 1867, it contributed 59 per cent. to the total value of all Chinese produce exported. In 1905 tea contributed only 11 per cent. to the value of exports, partly due to a great development in the trade in "sundries" (*i.e.* commodities other than tea and silk), but partly also to an absolute loss of the tea trade. For several centuries China had a monopoly in supplying the world with tea; India entered the market experimentally in 1838, and in 1852 shipped 232,000 lb. (1,740 piculs) to England; Japan was thrown open in 1858; Ceylon and Java took up the industry about 1883; and in 1905 China maintained her supremacy only in the Russian market. The following table shows her downward course in supplying Western markets:—

PROVENANCE OF TEA EXPORTS.

	1867.		1886.		1905.	
	Piculs.	Per cent.	Piculs.	Per cent.	Piculs.	Per cent.
China—Tea leaf	1,248,256	85·8	1,846,989	58·6	839,173	17·8
China—Brick tea	65,311	4·5	370,212	11·7	530,125	11·2
Japan	89,544	6·1	275,823	8·8	298,422	6·3
India	53,130	3·6	551,078	17·5	1,617,380	34·3
Ceylon	..	..	60,833	2·0	1,238,260	26·4
Java	..	..	44,010	1·4	191,025	4·0
	1,456,241		3,148,945		4,714,385	

In 1867 China supplied the Western world, including Asiatic Russia, with 90 per cent. of its consumption of tea, and in 1905 with only 29 per cent., including both the highly priced tea leaf and the commoner brick tea; but in 1867 tea leaf constituted 95 per cent. of the Chinese export, and in 1905 only 61 per cent. Markets have been lost as well. In 1867 the import into England came 95 per cent. from China, and 5 per cent. from India; in 1905 of the consumption of the United Kingdom, only 2½ per cent. came from China. Of the import into the United States in 1867, China supplied 68 per cent. and Japan 32 per cent., while in 1905 China supplied 40 Japan (including Formosa) 35, and other sources 25 per cent. Australia in 1867 took all her tea from China; in 1905, of a consumption of 246,750 piculs (33 million lb.) China supplied less than 2 per cent. Russia, which in 1867 took all her tea from China, still gives China her principal market; in 1906 (war in 1905), of China's export of tea leaf and brick tea, 67 per cent. was declared for Russia, including Siberia; and in 1906, of the Russian

consumption of tea leaf (118½ million lb.) 60 per cent., and of brick tea (86½ million lb.) 92 per cent. came from China.

Silk and its manufactures in 1867 came next to tea, the value being 33 per cent. of that of all exports; in 1908 silk had risen to first place with 30 per cent. Of raw silk China has maintained its percentage in supplying the Western markets, and in doing so has more than trebled her quantities, as shown in the following table:—

PROVENANCE OF SILK.

	China.	Japan.	India.	Levant.	France and Italy.	Total.
1867. Metric tons	2,338	633	627	..	2,939	6,537
1877. ,, ...	3,548	1,101	672	621	2,448	8,390
1887. ,, ...	3,870	2,217	528	738	4,535	11,888
1898. ,, ...	6,945	3,122	275	1,479	4,877	16,698
1908. ,, ...	7,975	7,531	250	2,693	5,551	24,000

During the first and second phases raw silk, except the quantities required for the United States, went to London and was there bought for the French and Italian weavers; during the third phase the Continental trade bought its silk in China and imported it direct, its value constituting at the end of the third phase 85 per cent. of all exports to France and Italy. In woven silks China has lost her premier position among the Asiatic nations; in 1867 Chinese woven silks exported were valued at 2½ million taels, while the Japanese export was inconsiderable; in 1906 the figures were, China 11 million taels, Japan 26 million taels.

Sundries—the old-time China merchant's "chow-chow cargo"—in 1867 constituted 8 per cent. of all exports; in 1905 they had risen in importance to 58 per cent., and this vast development was due solely to the energy of the foreign traders, the Chinese being apathetic.

[*The remainder of the paper and the discussion will be printed in the next number of the "Journal."*]

THE DEVELOPMENT OF THE TEXTILE INDUSTRIES.

The Dye Supply.—Deliveries of dyestuffs under the reparation clauses of the Peace Treaty are relied on to give manufacturers a freer hand in the use of colour than they have had for five years past. Nobody has gone without dyes, but the selection has been restricted, and of necessity those colours which have been scarcest have had to be sparingly used. The coloured stripes in men's shirtings are widening now that producers feel sure of larger supplies of the so-called vat colours. These are dyes developed upon the fibre, and valuable not so much for any brilliance of shade as for their fastness to all the trials of the wash-tub. The stripes have been narrow hitherto because makers of shirtings did not dare to employ two threads of coloured yarn if they could make shift with one. Exceptionally fast colours and those of extraordinary brightness and delicacy have been the most difficult to procure. The latter are used not solely as self-colours, but to enliven shades produced by the mixture of less fine colour stuffs.

Points of Perfection.—The austerer beauties of textile art excite less notice than do the pronounced qualities of the more ambitiously decorative goods. There is skill of course in the nice placing and colouring of a simple stripe, although its exercise is taken very much for granted. The purity of a white or the precise degree of sheen upon a surface may not actually escape attention, but these characteristics are difficult to appraise, and it is possible that nobody but the men who have done the work know all that it has cost in the way of research, effort and ingenuity to reproduce them an infinite number of times over. Simple-looking triumphs always run the risk of neglect, but justice cannot be done to textile skill without paying regard to minutiæ which barely lend themselves to exact description. One might be hard put to it to explain, for example, wherein the best cotton goods of to-day improve upon those of ten, twenty or thirty years ago. But the fact of an improvement is not to be denied, and it is evident that such advance as there has been resides in a series of almost ultra-microscopical fine points.

A New Material.—A new cotton fabric produced by the Calico Printers' Association under the name of Sheenore marks a real advance in the production of fancy cotton goods. In texture the cloth resembles the printed voiles now so largely worn, and it is printed albeit only upon the warp threads. The process of warp or *chaine* printing, long followed upon silks and upon heavy cotton goods has not hitherto been found practicable upon light cottons. The operation of printing has been found to make the warp tender, or short of strength, but that is certainly not the case in the instance under notice. The weft, or crossing threads, are dyed to a shade contrasting with the bright colours used in printing upon the warp. After weaving and finishing the effect is a "shot," but not a plain shot. The printed design peers from beneath the weft with greater or less prominence according to the angle made with the eye. It follows that a remarkably lively appearance is made with the

fabric draped and in motion, and it is safe to say that nothing like it has been produced in cotton before. The article is by no means cheap, and perhaps can never be made very cheaply, but it is not seriously less notable upon that account, and it is safe of its public.

Printed Silks.—Printed designs are in for a new vogue next year, and it appears to be settled that printed silks will be more seen than for twenty years past. It is not only light silks that are being printed but heavy satins and brocades as well, and they are being treated in rather violent colours and sometimes in sprawling designs. Large preparations have been made, and the demand will be met for everything from black or blue foulard with white spots up to satins printed in gold. The designs are not all eccentric, but some of those produced in Lyons run to unchastened extremes and will be none the worse for discreet use after reaching the dressmaker's hands.

Output.—The reduction of working hours in this and other countries to forty-eight per week would not yet seem to have evoked any corresponding increase in the output per hour. There has presumably not been time yet to make the readjustments which will be required, and there has been no great pressure of adversity to stimulate invention. Manufacturers are doing almost too well in the matter of profits and their employees have received compensation for their sacrifice of output. Normal incentives to get the last ounce out of the machines can scarcely be said to exist, but the desirability of getting the old output from the new schedule of hours is not actually forgotten. It is not especially to the good of the industry that a low rate of production should be as profitable as at present, but there may be some consolation in the knowledge that the case is much the same elsewhere as in our own country.

The Price of Clothing.—There are few visible prospects of cheaper clothes in 1920. Short of some unforeseeable event they will rule dearer rather than cheaper, and a fall in prices is deferred apparently to the Greek Kalends. Clothing is dearer in the European countries and America than here, and reports from Germany show that even a shoddy suit costs 350 marks. It looks as though a large part of the world would be reduced to the uneconomical necessity of clothing itself in rubbish, despite the accumulation of good wool existing in one part of the world or another. Already there are in the shops of this country suits for men made out of cloths that would hardly have been used for a servant girl's costume in 1914, and others made from cloths that would certainly have found no other use than in the very cheapest of little boys' suits. It is wasting energy to put into these products virtually the same efforts as would make a suit which would be satisfactory in wear. Prices are unconscionably high, but it is still the case that money is to be saved by paying well up to the market level. Proportionately, good clothes have not advanced as much as poor ones, and rubbish remains rubbish be the sale price what it may.

Causes of Dearness.—It has been abundantly shown that proceedings taken against retail distributors accused of profiteering have no influence at all upon the prices at which retailers buy. The beginnings of the dearness of clothes lie far back. It is apparent that the raw materials of textile industry fetch high prices in the open market, but not such prices as would explain the eventual cost to the consumer of finished goods. Wages, it is true, have doubled, or more than doubled, but neither do they explain more than a little of the increase in cost. The first marked advance in cost begins with the conversion of raw material into the semi-manufactured yarn, and it is apparent that spinners receive anything up to fifteen times their pre-war margin. The fact occurs not as the result of any conspiracy between them but as the consequence of the strength of demand upon their limited facilities. The weaving manufacturer pays dearly for his yarn and is able in existing circumstances to exact more than his normal profit. At every stage—and it is worth remembering that, in course of their progress, goods pass through about half-a-dozen sets of hands—something more than a starvation payment is exacted. The increase is a cumulative one and it does not all remain in private pockets. In fixing prices the several parties all have the Excess Profits Duty in view, and the fact that this duty is levied time and again upon the one set of goods has decidedly not been without influence in producing the state of affairs of which consumers with fixed incomes legitimately complain.

OBITUARY.

JOHN DIBBLEE CRACE.—The Society has lost one of its oldest Fellows by the death of Mr. John Dibblee Crace, which occurred on the 18th inst. at the age of eighty-one. Mr. Crace was elected a member of the Society in 1862. In 1888 he read a paper on "The Decorative Use of Colour" before the Applied Art Section. He frequently attended the Society's meetings and took part in the discussions.

Mr. Crace was the fifth of his family in direct descent to practise the art of decoration. When sixteen years old he joined his father in business, but he continued his education by various visits to foreign countries. He designed the decorative colouring of the new portions of the National Gallery, the "Victoria Hall" in Leeds, and the Indian Room at the Imperial Institute. He was deeply interested in education on the technical side of decorative art, and took an active part in founding travelling studentships. He visited Palestine in 1869, and soon after his return he

became connected with the Palestine Exploration Fund, acting first as a member of its council, and finally as its hon. secretary.

He published a book on "The Art of Colour Decoration," and he was throughout his life an indefatigable sketcher of very considerable talent. He also occasionally exhibited small pictures at the Royal Academy.

He was Master of the Painter Stainers' Company in 1884, a post which his father had filled in 1879, and his grandfather in 1851.

GENERAL NOTES.

Education in India.—The Joint Select Committee on Indian reforms briefly refer in their report to education in India. The question, they say, is far too large for them to make any attempt to deal with it adequately. They have accepted the recommendation of the "Functions Committee" that, subject to certain reservations about the universities, the responsibility for the whole field of education in each province should be transferred to the Ministers to be called into existence by the measure now before Parliament. They attach much importance, however, to the educational advancement of the "depressed and backward classes," and trust that the subject will receive special attention from Ministers. They are also impressed by the advantage of Boards such as Sir Michael Sadler has advised in Bengal for the assistance of Ministers in controlling the different grades of education.

Transvaal Tobacco.—Steps are being taken, according to *United Empire*, to establish an oversea market for Transvaal tobacco. Large areas of suitable land are still available in the north-western Transvaal, while the completion of the big Crocodile River dam at Hartebeeste Poort, which is being constructed by the Government at a cost of over £1,000,000, and should be finished in two or three years' time, will add some thousands of acres more to the area already given up to tobacco. A certain amount of South African tobacco was shipped to Europe and other parts of the world during the war for the use of the troops, but before then the quantity exported was almost negligible. Ever since the South African War of 1899-1902 small quantities of the better-known brands have been sent to England, but now that the production has so increased as to have a considerable surplus over and above local requirements, the question of developing an export trade has arisen. The total tobacco production of the Union at the present time amounts to about 10,000,000 lb. per annum, and of this the local market absorbs about 8,000,000 lb.

Trinidad Fustic Wood.—An important industry appears to have developed in Trinidad last year in supplying to the United States fustic wood, a product of the local forests, and used as a yellow dye, chiefly in connection with textile goods. The Trinidad product is claimed to be of superior dye strength to that from Mexico, whence most of the fustic sent to the United States is said to have been obtained. According to the United States Consul in Trinidad, the declared export returns of his office show that Trinidad exported, during 1918, 168,000 lb. of fustic wood to the United States, to the value of 1,880 dollars, and during the first three months of 1919 this quantity was very nearly equalled. Fustic wood, sometimes known as Bois d'Orange, is not only well known in Trinidad as a dye wood, but also as an excellent timber of unusual durability. Many of the trees are 13 to 14 ft. in girth, but a fair average would be about 5 ft.; a tree of this size would give from 3,000 to 5,000 lb. of the commercial product. A fair average cost of the product in the vicinity of the forest in which it is cut, including the cost of the trees, which is paid to the Government, is about 10 dollars a ton of 2,240 lb. This prime cost, however, is seriously augmented by the heavy cost of transporting the logs to Port of Spain, so that the average cost of production is brought up to about 25 dollars per ton. In the Government forests all along the southern coast of Trinidad, fustic trees appear to be in great abundance. They are also found in the smaller island of Tobago, just north of Trinidad. Fustic wood is also valuable to local wheelwrights for naves and felloes, and probably fine furniture might be made from it.

Naval Direction-finding Stations.—The Canadian Department of Naval Service has established on the east coast of Canada four direction-finding stations which should prove of great value to vessels unable to determine their position owing to fog. These stations are at Cape Sable, at the mouth of Halifax Harbour, at Cape Canso, and Cape Race, Newfoundland. From any of these a vessel equipped with wireless can obtain a bearing while at a distance of several hundred miles from the coast.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

December 3.—John Westall Pearson, Chairman and Director, British Oil and Cake Mills, "The Oil Seed Crushing Industry." The Right Hon. Lord Lamington, G.C.M.G., G.C.I.E., will preside.

December 10.—Sir Oliver Lodge, D.Sc., Sc.D., LL.D., F.R.S., "Some Possible Sources of Energy." (Trueman Wood Lecture.) The Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., D.Sc., F.R.S., will preside.

December 17.—Constantine Grunewald, late Chief of Intelligence Department, Russian

Ministry of Trade and Industry, "The Present Economic Position of Russia, and some Aspects of its Future Development."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 p.m. :—

DECEMBER 9.—SIR EDWARD DAVSON, President of the Associated West Indian Chambers of Commerce, "Problems of the West Indies." LIEUT.-COLONEL L. S. AMERY, M.P., Under-Secretary of State for the Colonies, will preside.

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.

DECEMBER 18.—P. J. HARTOG, C.I.E., M.A., Member of the Calcutta University Commission, 1917-1919, "Some Problems of Indian Education."

Papers to be read after Christmas :—

AIR-COMMODORE EDWARD MAITLAND, C.M.G., D.S.O., "The Commercial Future of Airships."

SIDNEY PRESTON, C.I.E., "English Canals and Inland Waterways."

BRIGADIER-GENERAL SIR HENRY P. MAYBURY, K.C.M.G., C.B., M.Inst.C.E., "Road Transport."

CHARLES H. SHERRILL, "Stained Glass."

ALFRED E. HAYES, General Secretary, English Language Union, "The English Language and International Trade."

JAMES CURRIE, C.M.G., Ministry of Labour (Training Department), late Principal, Gordon Memorial College, Khartoum, "Industrial Training."

LADY INGLEFIELD, President, Buckinghamshire Lace Association (North Bucks and Bedfordshire), "The Hand-made Lace Industry."

GRAILY HEWITT, "Rolls of Honour."

ALFRED H. POWELL, "Ancient Cottages and Modern Requirements." The Right Hon. EARL FERRERS will preside.

CHARLES CROWTHER, "The Arts and Crafts of Japan" (with examples from the author's private collection).

SIR CECIL HERTSLET, late H.M.B. Consul-General for Belgium, "The Ruin and Restoration of Belgium." EMILE CAMMAERTS will preside.

WILLIAM CRAMP, D.Sc., M.I.E.E., "Pneumatic Convoying Plants, with special reference to the Transport of Grain."

L. GASTER, "Industrial Lighting in its relation to Efficiency."

H. M. THORNTON, "Gas in relation to Industry and Housing."

LIEUT.-COMMANDER NORMAN WILKINSON, R.N.V.R., O.B.E., R.O.I., R.I., "Naval Camouflage."

BRIGADIER-GENERAL LORD MONTAGU OF BEAULIEU, C.S.I., "Roads and Transport in India."

SIR GEORGE CUNNINGHAM BUCHANAN, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

SIR JOHN HUBERT MARSHALL, C.I.E., M.A., Litt.D., F.S.A., Director-General of Archæology in India, "Recent Archæological Discoveries in India."

SIR VALENTINE CHIROL, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

SIR FRANCIS WATTS, K.C.M.G., D.Sc., Imperial Commissioner of Agriculture for the West Indies, "Tropical Departments of Agriculture, with special reference to the West Indies." LIEUT.-COLONEL SIR DAVID PRAIN, C.M.G., C.I.E., LL.D., F.R.S., Director of the Royal Botanic Gardens, Kew, will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m. :—

January 15, February 19, March 18, April 15, May 20.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m. :—

February 3, March 2, May 4.

CANTOR LECTURES.

Monday evenings, at 8 p.m. :—

JOHN THEODORE HEWITT, M.A., D.Sc., Ph.D., F.R.S., Emeritus Professor of Chemistry, East London College, "Synthetic Drugs." Three Lectures.

Syllabus.

LECTURE I.—DECEMBER 1.—Introductory—Simple aliphatic compounds—Alcohols, formaldehyde, paraldehyde—Ketones and derivatives such as sulphonal—Veronal and other compounds derived from urea—Non-aromatic cyclic compounds, *e.g.* the derivatives of Borneol.

LECTURE II.—DECEMBER 8.—Phenol, salicylic acid and related substances—Derivatives of aromatic amines and aminophenols, *e.g.* phenacetin—Compounds of heterocyclic structure, antipyrine, flavine, etc.

LECTURE III.—DECEMBER 15.—Modified alkaloids, *e.g.* heroin, euquinine—Organic compounds of arsenic (atoxyl, salvarsan), antimony, mercury and other metals—Conclusion.

CAPTAIN H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S., Fellow of Downing College, Cambridge, and formerly of the Royal Air Force, "Aircraft Photography in War and Peace." Three Lectures.

January 19, 26, February 2.

CHARLES FREDERICK CROSS, B.Sc., F.R.S., F.C.S., "Recent Research in Cellulose Industry." Three Lectures.

February 16, 23, March 1.

WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758-1837." Three Lectures.

May 3, 10, 17.

JUVENILE LECTURES.

Wednesday afternoons, at 3 p.m.:—

LOUGHNAN PENDRED, M.I.Mech.E., Editor of *The Engineer*, "Railways and Engines."

January 7, 14.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DECEMBER 1...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Dr. J. T. Hewitt, "Synthetic Drugs." (Lecture I.)

Swiney Lectures, Imperial College of Science, South Kensington, S.W., 5.30 p.m. Dr. J. D. Falconer, "The Geology and Mineral Resources of the British Possessions in Africa." (Lecture X.)

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Society of, at the Geological Society, Burlington House, W., 5.30 p.m. Captain R. Twelvetrees, "Mechanical Transport in the War."

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. 1. Mr. A. Henning, "Ethyl Chloride." 2. Mr. C. E. Barrs, "The Influence of Impurities in Lead when it is heated with Concentrated Sulphuric Acid."

Geographical Society, 135, New Bond-street, W., 8.30 p.m. Mr. H. W. Fox, "Development of Transport on the Great Lakes of Africa."

British Architects, Royal Institute of, 9, Conduit-street, W., 8 p.m.

Electrical Engineers, Institution of (Western Centre), Technical College, Bristol, 7 p.m. Address by Mr. W. A. Chamen.

TUESDAY, DECEMBER 2...Industrial League, Council Chamber, Guildhall, E.C., 4.30 p.m. Sir G. Paish, "League of Nations."

Electrical Engineers, Institution of (North-Western Centre), 17, Albert-square, Manchester, 7 p.m. Discussion on "Electricity Supply."

University of London, University College, Gower-street, W.C., 5.30 p.m. Mr. J. H. Helweg, "Holberg and Ewald." (Lecture V.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Discussion on Mr. M. F. Wilson's paper, "Admiralty Harbour, Dover."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. A. H. Lisett, "Lantern-slide Making."

Horticultural Society, Vincent-square, Westminster, S.W., 3 p.m.

Marine Engineers, Institute of, The Minories, Tower-hill, E., 6.30 p.m. Address by the President.

WEDNESDAY, DECEMBER 3.—ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. J. W. Pearson, "The Oil Seed Crushing Industry."

Automobile Engineers, Institution of, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. Mr. E. N. Duffield, "Car Designs and Car Usage from the Point of View of the Majority of Owner Drivers."

Swiney Lectures, Imperial College of Science, South Kensington, S.W., 5.30 p.m. Dr. J. D. Falconer, "The Geology and Mineral Resources of the British Possessions in Africa." (Lecture XI.)

Geological Society, Burlington House, W., 8 p.m.

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m.

Oriental Studies, School of, Finsbury-circus, E.C., 5 p.m. Mr. L. Binyon, "The Art of Asia." (Lecture III.)

United Service Institution, Whitehall, S.W., 3 p.m. Air-Commander H. R. Brooke-Popham, "The Air Force."

Electrical Engineers, Institution of (South Midland Centre), The University, Birmingham, 7 p.m. Mr. G. L. Addenbrooke, "Dielectrics."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Professor W. L. Courtney, "Some Dramas of D'Annunzio."

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. G. C. Druce, "The Elephant in Mediæval Legend and Art."

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Mr. R. Unwin, "Town Planning—Its Influence on the Health and Well-Being of the Citizen."

University of London, University College, Gower-street, W.C., 5.30 p.m. Mr. I. C. Grondahl, "Holberg and Wessel." (Lecture V.)

6.15 p.m. Dr. J. C. Stamp, "Fundamental Principles of Taxation in the Light of Modern Developments." (Lecture V.)

THURSDAY, DECEMBER 4...University of London, University College, Gower-street, W.C., 5.30 p.m. Professor A. Cippico, "La Poesia di Giovanni-Pascoli." (Lecture VI., in Italian.) Mr. I. Bjorkhagen, "Selma Lagerlof." (Lecture V.)

Royal Society, Burlington House, W., 4.30 p.m.

Child Study Society, at the Royal Sanitary Institute, 90, Buckingham Palace-road, S.W., 6 p.m. Rev. W. F. Cobb, "Religion in Education."

Chemical Society, Burlington House, W., 8 p.m. 1. Mr. H. Henstock, "X Di-phenanthryl." 2. Messrs B. D. Steele and H. G. Denham, "A New Sulphuretted Hydrogen Generator."

FRIDAY, DECEMBER 5...Technical Inspection Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.30 p.m.

Swiney Lectures, Imperial College of Science, South Kensington, S.W., 5.30 p.m. Dr. J. D. Falconer, "The Geology and Mineral Resources of the British Possessions in Africa." (Lecture XII.)

University of London, University College, Gower-street, W.C., 8 p.m. Professor G. D. Hicks, "An Introduction to Modern Philosophical Thinking." (Lecture V.)

Philological Society, University College, Gower-street, W.C., 8 p.m. Mr. H. O. Coleman, "Existing Parts of Speech-Distinctions have no Logical Basis."

Geologists Association, University College, Gower-street, W.C., 7.30 p.m. Mr. W. B. R. King, "Geological Work on the Western Front."

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FRIDAY, DECEMBER 5, 1919.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, DECEMBER 8th, at 8 p.m. (Cantor Lecture.) JOHN THEODORE HEWITT, M.A., D.Sc., Ph.D., F.R.S., Emeritus Professor of Chemistry, East London College, "Synthetic Drugs." (Lecture II.)

TUESDAY, DECEMBER 9th, at 4.30 p.m. (Colonial Section.) SIR EDWARD DAVSON, President of the Associated West Indian Chambers of Commerce, "Problems of the West Indies." LIEUT.-COLONEL L. S. AMERY, M.P., Under-Secretary of State for the Colonies, will preside.

WEDNESDAY, DECEMBER 10th, at 4.30 p.m. (Trueman Wood Lecture.) SIR OLIVER LODGE, D.Sc., Sc.D., LL.D., F.R.S., "Some Possible Sources of Energy." The Hon. SIR CHARLES ALGERNON PARSONS, K.C.B., LL.D., D.Sc., F.R.S., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

COLONIAL SECTION.

A meeting of the Colonial Section Committee was held on Monday, December 1st. Present:—

Lord Blyth (Chairman of the Section) in the chair; R. E. Brounger; The Hon. Sir John A. Cockburn, K.C.M.G.; Edward Dent, M.A.; Major E. H. M. Leggett, R.E., D.S.O.; and George Wilson, C.B.; with G. K. Menzies, M.A. (Secretary of the Society), and S. Digby, C.I.E. (Secretary of the Section).

CANTOR LECTURE.

On Monday afternoon, December 1st, DR. JOHN THEODORE HEWITT, F.R.S., Emeritus Professor of Chemistry, East London College, delivered the first lecture of his course on "Synthetic Drugs."

The lectures will be published in subsequent numbers of the *Journal*.

THIRD ORDINARY MEETING.

Wednesday, December 3rd, 1919; The Right Hon. LORD LAMINGTON, G.C.M.G., G.C.I.E., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Agar, Alfred, Belfast.
Barton, Alfred Danell, A.M.I.A.E., London.
Bishop, Edwin Kelsham, London.
Briggs, Roland Hunter, A.M.I.Mech.E., Harrow-on-the-Hill, Middlesex.
Britten, William Robert James, Horley, Surrey.
Brown, Alexander, Belfast.
Gill, Geoffrey M., London.
Gooby, Alfred H., London.
Hart, James Connorton, M.P.S., London.
Ide, H. W. F., London.
Longcroft, Cecil J., London.
Newnes, Sir Frank, Bt., London.
Pearson, John Westall, London.
Russell-Cotes, Sir Merton, J.P., Bournemouth.
Smout, Arthur John Griffiths, A.I.C., A.I.M.M., F.C.S., King's Heath, Birmingham.
Turrell, Frank William, King's Heath, Birmingham.

The candidates proposed at the opening meeting on November 19th, of whom a list was published in the *Journal* of November 21st (pp. 2 and 3), were duly elected Fellows of the Society.

A paper on "The Oil Seed Crushing Industry" was read by Mr. JOHN WESTALL PEARSON, Chairman and Director of the British Oil and Cake Mills.

The paper and discussion will be published in the next number of the *Journal*.

JUVENILE LECTURES.

The usual short course of lectures adapted to a juvenile audience will be delivered on Wednesday afternoons, January 7th and 14th, 1920, at 3 p.m., by Mr. LOUGHNAN PENDRED, M.I.Mech.E., Editor of *The Engineer*, on "Railways and Engines."

Special tickets are required for these lectures. They can be obtained on application to the Secretary.

A sufficient number of tickets to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each Fellow is entitled to a ticket admitting two children and one adult. Fellows who desire tickets are requested to apply for them at once.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and copies can be obtained on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

SECOND ORDINARY MEETING.

BRITISH TRADE IN CHINA.

By H. B. Morse, LL.D.,
Late Statistical Secretary, Inspectorate-General of Chinese Customs.

(*Continued from page* 28.)

Beans were first recorded in 1870 with an export of 578,209 piculs, and beancake in 1890 with 96,297 piculs; the trade in them increased: in 1905—beans 2,665,523 piculs, beancake 2,897,948 piculs; in 1912—beans 10,304,180 piculs, beancake 8,162,989 piculs. *Bristles* were first recorded in 1894 with 18,378 piculs, increased in 1907 to 42,124 piculs. *Cotton* in China is both imported and exported. The import of the first phase was not maintained, but, in 1867, still amounted to 336,072 piculs; in 1905 it was 90,581 piculs, and in 1918 was 190,110 piculs. Exports were 29,391 piculs in 1867, but in 1905 they were 789,273 piculs, and in 1918 rose to 1,292,094 piculs, all to Japan, with a war value of 38 million taels (14½*d*. a lb.). *Firecrackers* were shipped from Canton to America, 16,186 piculs in 1867, and 166,076 piculs in 1907. *Matting*, also from Canton to America, 89,908 rolls of 40 yards in 1867, and 478,851 rolls in 1907. *Fibres* (hemp, jute and ramie) were first recorded in 1879 with 10,456 piculs, and increased to 300,882 piculs in 1905, and 523,923 piculs in 1918; but China's capacity for the production of fibres has scarcely been touched. In 1905 the export amounted to 18,000 tons, and in 1913 to 21,400 tons; from British India, with no larger area or population, the export of hemp and jute in 1905 was 675,000 tons.

Hides were exported in 1867 to the small amount of 146 piculs; in 1918 their export was 425,045 piculs of cow and horse hides, and 9,656,933 pieces of goat and sheep hides undressed. *Skins*, dressed, chiefly of goat, kid and lamb, were valued in 1867 at 5,501 taels and in 1907 at 7,439,821 taels. *Oil seeds* (cotton, rape and sesamum) have only recently entered into the foreign trade; in thirty years the export, in piculs, has been as follows:—

	1888.	1898.	1908.	1918.
Rape . . .	873	212	54,074	670,126
Cotton . . .	..	566,105	191,077	165,303
Sesamum .	3,027	47,388	1,792,435	234,103

The rape and cotton seed went entirely to Japan, and the sesamum, prior to the war, went chiefly to Germany and France. *Expressed oils* were exported, 1,142 in 1867, and 3,651,511 piculs in 1918; of the last figure the oil of the soya bean has furnished nearly two-thirds, with groundnut and wood-oil (from the nut of the Aleurites) coming next. Of *Strawbraid* the export in 1867 was 1,361 piculs, and in 1907 was 103,246 piculs; in 1918 it was only half the latter amount. *Human hair* was first exported after the revolution of 1911-12, causing the abolition of the queue as the badge of Manchu supremacy; in 1913 the export was 24,477 piculs, and in 1918 it was still maintained at 14,382 piculs.

We come now to the consideration of the trade in foreign products imported into China.

Opium.—The value of the import in 1867 was 32 million taels; in 1905 (the last year before the opium reform edict) it was 34 million; and in 1918 it had disappeared from the statistics, except for a quantity of 333 piculs of Persian opium imported from Japan for consumption in the leased territories of Dairen and Kiaochow—under Japanese control. Its decline in importance is shown by the following table of the percentage of opium to all foreign imports:—

Year . .	1818.	1833.	1867.	1905.	1918.
Per cent. .	11	50	46	7½	..

Cotton manufactures were not imported in 1833. In 1867 their value was 21 per cent. of the value of all imports, and in 1905 it was 40 per cent.

Cotton yarn was imported in 1867 to the extent of 33,274 piculs, entirely of English spinning; it was of the finer counts, with an average value of 48 taels (£16) a picul; and its total value was 11 per cent. of all cotton

products. In 1905 the import was 2,577,748 piculs, viz.:—

English	22,075 piculs,	of the finer counts.
Indian	1,867,809 „	Mainly of the coarser counts, 12's to 24's.
Japanese	684,671 „	
Hong Kong	3,693 „	

The average value was 26 taels (£3 18s.) a picul, and the total value was 36 per cent. of all cotton products; in 1903 and 1904 the percentage of yarn had been 52 and 48 respectively. If we add the value of the machine-spun yarn from the factories in Shanghai and other Treaty Ports of China, it may be declared that normally well over half of all foreign cotton products is in the shape of the semi-finished product yarn. It is used to give a strong warp, on which the people in their homes weave a coarse durable fabric, filling in with a hand-spun weft of Chinese cotton; it penetrates to every corner of the country (386,669 piculs in 1906 to Chungking, on the upper Yangtze, 1,400 miles from the salt water), and in every village street may be seen the long white stretches arranged by the women in preparation for the weaving.

Of plain cotton fabrics (shirtings, sheetings, T. cloths, drills, jeans, etc.) the import in 1867 was 3,738,965 pieces, about 119 million square yards, of which about 130,000 pieces came from the United States, and the rest mainly from England; their value was 72 per cent. of all cotton products. In 1905 the import was 28,702,693 pieces, about 1,167 million square yards, and their value was 48 per cent. of all cotton products; their country of origin was as follows:—

	Pieces.	Square yards.
English	14,393,846	589,200,000
American	12,693,793	519,770,000
Japanese	789,290	30,530,000
Indian	651,011	22,330,000
All others	174,753	5,770,000

In 1918 the greater part of the import was of Japanese weaving.

Of fine cotton fabrics the import in 1867 was 781,359 pieces, about 16 million square yards, almost entirely of English weaving; and their value was 17 per cent. of all cotton products. In 1905 the import was 10,821,885 pieces, about 220 million square yards, and their value 15 per cent. of all cottons; of this value 84 per cent. was of English weaving, 7 per cent. of American, and 5 per cent. Japanese. These fine cottons were, in 1905, to the extent of 70 per cent. made up of cotton imitations, cheap substitutes for more expensive woollen fabrics—flannel, blankets, Italians, lastings, Spanish stripes, etc. —for China is a land of cheapness.

Imports other than opium and cotton products were valued in 1867 at 22½ million taels, being 32 per cent. of all foreign imports. In 1905 their value was 237 million taels; but with this tenfold increase in value, the percentage rose to only a little over 50.

Woollens were imported in 1867, with a value of 7½ million taels, being 10 per cent. of all imports; in 1905 the value was 4½ million taels, less than 1 per cent. of all imports. The Chinese in the past have not wanted our woollens; the well-to-do have always preferred their native silks, and the poorer classes have worn winter clothing of wadded cotton, and in the north have warmed themselves with sheepskin coats in their fireless homes. The establishment of the Republic has brought with it the adoption of Western garb by many thousands of the gentry, and that involves an increase in the use of woollens; but the import in 1913 was under 5 million taels (nearly a third yarn), and the value has not in any of the subsequent years of war reached 4 million taels.

Metals in 1867 were 1½ million taels, 2 per cent. of all imports; and in 1906 were 20 million, 5 per cent.; in 1905 the value had been 46 million, over 10 per cent., but that was inflated by an enormous exceptional importation of copper for the mints, which were coining money in a double sense. Iron and steel rose from 7,000 tons in 1867 to 161,500 tons in 1905; and tinplate from 104 tons to 10,400 tons; but to those figures have to be added the large quantities of hoop iron, tin linings, and tin containers, used for baling and casing those commodities which require protection; no record is kept of those quantities, but in China nothing is wasted—nothing thrown away, nothing given away.

Foreign *coal* was imported in 1867 to the amount of 113,439 tons, with practically no Chinese coal brought to the treaty ports; in 1905, about 400,000 tons of Chinese coal were moved from port to port, and 1,314,032 tons of foreign coal were imported, mostly from Japan; the import into Hong Kong was probably not much less. *Cigarettes* were unknown in 1867; in 1905 their value was 4½ million taels, of which a half came from the United States, a fourth from England, a fourth from Japan; in 1913 the value was 12½ million taels, of which more than two-thirds were from England; in 1917 the value was 31½ million taels, a half from the United States, tenth from Canada (probably also from the United States), and a fifth from England. *Aniline dyes* were not recorded in 1867, when

the Chinese still used their native dyes; in 1913 the value was 5½ million taels, in addition to 9½ million taels of synthetic indigo to displace the natural indigo of the country. Nearly all these dyes came from Germany.

The taste for foreign luxuries has been introduced by returned emigrants, and *wheat flour*, with no import in 1867, was imported in 1913 to the extent of 156,000 tons, mostly from the United States, but about 40,000 tons (perhaps American flour) were imported from Japan to Dairen. *Window glass* and *glassware* were valued in 1867 at 25,000 taels, and in 1913 at 2¼ million taels. *Matches* in 1867 figured for 79,236 gross of boxes, valued at one tael (6*s.* 8*d.*) a gross; and in 1913 for 28½ million gross, valued at 0·223 tael (8 pence) a gross, coming 99 per cent. from Japan. On the other hand 2,000 tons of flints were carried from England to China in 1867, and soon after that disappeared from the returns.

Kerosene oil was in 1867 imported, to the extent of 29,842 American gallons,* for the use of the foreign residents only. The trade began to expand in 1878, when the import was 4 million gallons, all from the United States; Russian oil was introduced in 1889, Sumatran in 1894, and Borneo oil in 1901. The import in 1913 was 184 million gallons, of which 61 per cent. were American, 13 per cent. Borneo, 3 per cent. Russian, and 23 per cent. Sumatran.

Of *sugar* the import in 1867 was 11,080 tons, entirely Chinese sugar reimported into China from Hong Kong. In 1913 the import was 423,330 tons, of which about 6,500 tons may have been Chinese sugar reimported; but of the rest, 17 per cent. was sugar refined in Hong Kong from crude sugar originally imported from the Dutch Indies and the Philippines; 20 per cent. was refined in Japan from Formosan sugar; 31 per cent. was crude brown and 28 per cent. was soft white sugar, imported from the Dutch Indies, the Philippines and Formosa, either direct or through Hong Kong.

These are the most important categories in the foreign trade of China; but, before considering the distribution between the different countries I will deal with the Balance of Trade.

In the first phase the trade was balanced only by the constant importation of silver dollars, until, towards its close, a way was found, through opium and cotton, of providing the funds required for buying the tea and silk for which the foreign traders came to China. These means, supplemented by the discovery of Manchester, sufficed to carry the trade through the second phase, except that in the crisis of the Taiping rebellion, through the combined action of the hoarding of silver, and of the large quantities of silk thrown on the market, the foreign traders were driven to resume the importation of silver dollars to avert disaster. In the third phase the tide gradually turned the other way, and, by the opening of the twentieth century, the value of imports constantly exceeded that of exports—by 82 million taels in 1903, by 80 million in 1909, by 167 million in 1913, and even in 1918, in time of war with no importation of opium, by 70 million taels. In 1904 I made some investigation of the visible and invisible assets and liabilities of China in her commercial dealings with foreign countries; and in the following table I give a summary of the results, together with supplementary figures in later years by my successor:—

* Ten American gallons equal 8·34 British imperial gallons.

	1903. Million taels.	1909. Million taels.	1913. Million taels.
LIABILITIES.			
Merchandise imported	316	418	570
Bullion and coin imported	37	32	59
Loans and indemnities	44	54	58
Chinese Legations, Consulates, and students studying abroad	4	33	31
Freights, insurance, and profits of foreign traders in China	23		
	424	537	718
ASSETS.			
Merchandise exported	236	339	403
Bullion and coin exported	33	22	24
Unrecorded land trade	4		
Proceeds of loans for development of railways, mines, etc.	27		
Foreign Legations, Consulates, garrisons, navies, in China	28	77	77
Foreign merchant ships, maintenance and repairs	12		
Foreign missions, hospitals, schools, and travellers	12		
Remittances from Chinese emigrants	73	100	100
	425	538	604

DESTINATION OF EXPORTS FROM CHINA.

Country.	1833.		1867.		1905.	
	Amount 000 taels.	Per cent.	Amount 000 taels.	Per cent.	Amount 000 taels.	Per cent.
United Kingdom	8,615	58·1	38,537	66·6	18,179	7·0
British India	..	..	347	0·6	10,108	3·9
Singapore*	..	..	1,560	2·7	18,240	7·0
Australasia	..	..	2,717	4·7	2,309	0·9
Canada, Ceylon, South Africa, etc.	..	..	..	..	1,759	0·6
British Empire	8,615	58·1	43,161	74·6	50,595	19·4
Russian Empire	..	..	1,041†	1·8	38,645	14·8
German Empire					11,500	4·4
France	667	4·4	3,121	5·4	43,055	16·5
Italy					20,741	8·0
Other European countries					10,383	4·0
Continent of Europe (including Siberia)	667	4·4	4,162	7·2	124,324	47·7
United States	5,581	37·5	8,672	15·0	40,325	15·5
Japan	..	..	1,116	2·0	36,564	14·0
Other Asiatic countries	..	..	694	1·2	8,821	3·4
Total	14,863	100·0	57,805	100·0	260,629	100·0

PROVENANCE OF IMPORTS INTO CHINA.

Country.	1833.		1867.		1905.	
	Amount 000 taels	Per cent.	Amount 000 taels.	Per cent.	Amount 000 taels.	Per cent.
United Kingdom	1,670	10·5	28,631	41·3	114,310	23·5
British India	11,730§	73·3	32,238§	46·5	97,600	20·1
Singapore‡	..	..	1,525	2·2	10,353	2·1
Australasia	..	..	1,179	1·7	5,743	1·1
Canada, Ceylon, South Africa, etc.	..	..	..	..	1,935	0·4
British Empire	13,400	83·8	63,573	91·7	..	47·2
Russian Empire	..	..	208§	0·3	16,925	3·5
German Empire					24,700	5·1
France	500	3·1	554	0·8	2,194	0·4
Italy					908	0·2
Other European countries					17,375	3·6
Continent of Europe (including Siberia)	500	3·1	762	1·1	..	12·8
United States	500	3·1	693	1·0	87,977	18·2
Japan	..	..	2,149	3·1	78,328	16·1
Other Asiatic countries	1,600	10·0	2,152	3·1	27,365	5·7
Total	16,000	100·0	69,329	100·0	485,715	100·0

* Singapore resembles Hong Kong in being a distributing centre for countries to north and south.
† Tea *via* Kiakhta only.
‡ Singapore resembles Hong Kong in being a collecting centre for countries to north and south.
§ Trade by land frontier not included.

We come now to the distribution of the trade—the countries from which the imports came, and those to which the exports went. Here we are confronted by a difficulty. The Chinese customs have no power to demand declarations or certificates of origin or destination, and cannot go behind the bill of lading or the voluntary declaration of the trader. When German goods pass through Genoa or Antwerp, or American goods through Yokohama, they have to be assigned to Italy, Belgium or Japan respectively. So, too, the products of all the nations, passing through Hong Kong, lose their identity, and must, in the Chinese Customs returns, be assigned to that port. But Hong Kong produces little outside its refining of imported sugar, and its consumption is (was in 1905) that of a population of a third of a million. Commercially it is a collecting and distributing centre for South China in precisely the same degree that Shanghai is for Central China; and in any serious consideration of China's place in world trade, Hong Kong must be treated as part of the Chinese commercial area, regardless of the flag that flies over it.

The simpler trade of 1867, in so far as it was camouflaged by Hong Kong, Antwerp and other distributing ports, I found that I could analyse without difficulty. For 1905 I took the returns of all the countries of the commercial world, and abstracted from them particulars of their trade with China and Hong Kong—their special trade, excluding transit trade. I was thus able to make out the tables on page 37 showing the actual distribution of the trade of China within a small margin of error.

On these tables I will comment very briefly. In the export table the showing of the United Kingdom is bad—the fact cannot be disguised. It is explained by three principal causes. In the first place England no longer buys China tea, but takes it now from her own empire—from India and Ceylon. You cannot eat your cake and still have it; and if you will grow your own tea, if you will develop your own possessions, you must be satisfied with the advantages from that, and cannot at the same time expect to retain your dominating position in the countries which formerly supplied you. In the second place, England has not taken her proper share in developing the new export trade of China: oil seeds go to Japan, France and Germany (I am considering solely pre-war conditions); fibres go mainly to Germany; and so on. This is partly due to lethargy, but principally to the fact that, here also, England draws her supplies from her own possessions—jute from India, palm-kernels from Nigeria, etc.—and it may be that the development of these possessions is a sufficient compensation for the relative loss of the Chinese trade.

For the third principal cause there is no such compensation. Through the whole of my first and second phases, down to 1867, London was the Western world's market for silk; Lyons, Milan and New York silk-weavers went there for their raw material, and the London merchant levied his toll on the transaction. That had to end some day, and the end came with the opening of the Suez Canal; and now Lyons and Milan buy their Chinese silk in Shanghai and Canton.

The import table is more intricate and more interesting. The United Kingdom, in the first phase, could send little beyond a small quantity of woollens; in the second phase, it was discovered that Manchester cottons could be sent with profit to a country which, in the first phase, had sent cotton nankeens to England; and in the third phase this trade in cottons was greatly increased, with almost a monopoly of fine cotton cloths, for which a natural advantage is found in the soft Lancashire air, and supplying a full half of coarse cottons. While the English percentage of the whole import trade fell nearly a half, it was in a much larger trade, and the absolute amount increased four-fold from 1867 to 1905, an increase only partly due to the reduced value of the silver tael.

The percentage of British India fell more than half, but the absolute amount increased three-fold—made up with about 35 per cent. opium and nearly 55 per cent. cotton manufactures; and now (1919) opium has disappeared from the import trade, and India will depend mainly on her cotton yarn and coarse cottons for maintaining her hold on the Chinese trade.

The Russian increase is due to the inclusion of the value of the trade by the land frontier, for which no statistics of earlier years could be obtained.

Germany created a new trade, amounting in 1905 to 25 million taels, one-fifth of that of the United Kingdom; and, apart from synthethic dyes, her trade was maintained by two factors: her traders pushed into the market, hunted up buyers, gave them articles in the shape in which the buyers wanted them, and devoted themselves night and day to their work; her manufacturers turned out a cheap form of product ("billig und schlecht") adapted for a land of great poverty and great thrift. And German

did not eat German; they competed with the English and the Americans, but they combined their own conflicting interests.

Belgium also created a new trade, but it must be borne in mind that the Belgian mills are frequently the free-trade face of financiers of protectionist France—who supply their home trade from French mills, and their foreign trade from Belgian mills.

American trade shows a great development, due to three main causes. First, the creation of the demand for kerosene oil, and in the future for petrol. Secondly, the discovery of the fact that a country growing its own cotton can supply coarse cottons on better terms than one which must import its raw material, with the result that in 1905 the United States supplied 45 per cent. of the Chinese demand for such cottons. Thirdly, American business methods, which have been copied in many respects by the Germans, notably a very considerable elimination of the middleman.

Japanese trade had taken a stride forward in 1905; in 1913 its share in the export trade was close on 20 per cent., and in the import trade close on 25 per cent.; and in 1918, under war conditions, it had over a third of the export trade, and not far from half of the import trade. (The intervention of Hong Kong prevents a more accurate estimate.) This result was natural, in the case of a country contiguous to China, and one entering on a course of industrial development. Japan imports Chinese and Indian cotton and sends back to China her cotton yarn and coarse cotton cloth; and she makes the thousand little articles required in daily life cheaply and in a shape adapted to the Asiatic taste. In addition to her natural advantages, she sends her thousands of chapmen travelling through China, living as the Chinese live, speaking their language, and subsisting on the meagre profits of a peddling trade; and, even after peace conditions are restored, the Japanese will be formidable competitors in all the minor branches of trade, and they will be the more formidable because they will be supported by the political power of their government in all their purely commercial operations, and these will be in a country which demands cheapness before quality.

What you are really yearning to have me tell you is—what adverse conditions have been created by the war, and what must be done to re-establish the strong position which England has always held in the Chinese trade. I may point out that Japan, an adjacent country, whose industries have not been dislocated by the war, and which requires less tonnage to carry her products to the Chinese market, has acquired a very strong position, from which it will be difficult to dislodge her; much time must elapse before the English mills can furnish the supplies demanded, and the necessary tonnage be available; and much strenuous effort will be required to reconquer lost, and re-establish imperilled, markets. Beyond that it is not my business to give you directions for the future. That is the task of the business man—the Manchester man for the Manchester trade, the Sheffield man for the Sheffield trade—and just in the degree that the business man will share with his colleagues and rivals his knowledge and his reading of the situation, to that degree will he contribute to the extension of the market for English goods, and of his own market. Close corporations, exclusive dealings, trade secrets for one's own sole benefit, are things of the past; co-operation, amalgamation, alliance, are the watchwords of the future.

I will, however, suggest some needs of the future which occur to me, in the hope that they may be worked out by others.

Commercial Information. — The British Government receives reports from its consular agents—I have read many, and I much admire them. They are written annually, pass on their leisurely course through the Foreign Office and the Board of Trade, are printed, and, if you happen to hear of them and order copies of an individual report, you will have the satisfaction of reading in 1919 what were the conditions of trade in a given district in 1917. The American Government receives and publishes similar reports; but if a consul is seized with the idea of writing a note on a particular article or branch of trade, he sends it, the Government publishes it without the loss of a day, the mailing office addresses it by machinery according to a list of applicants for anything relating to that subject, and, when it is read, the news is fresh. It may be a half-page note on the size of egg-cups for Asiatic eggs, or a ten-page note on an experiment in smelting iron; it may give details of a new lode of nickel ore; it may refer to some change in banking practice; but, whatever it is, it is written without rhetoric for the information of the business world.

Commercial Attachés.—An idea is prevalent that men with business training should be selected for such a post. That is an error. The commercial attaché must be first of all a

diplomatist: he must ferret out the business secrets of the country he is working in, and the business secrets of his rivals in that country, much as the military attaché has to ferret out military secrets. A man who has qualified in the severe test of the Civil Service examinations, has then undergone the varied and broadening training of the China Consular service, and has then been selected by his superiors to be commercial attaché, is more likely to acquire the requisite knowledge of business methods and requirements, than a man with a solely business training is to acquire the other qualities needed. The China Consular service is a special service, requiring special training owing to the difficult language and to the complicated duties arising from the privilege of extra-territoriality enjoyed by all Europeans. I have known several commercial attachés and formed a respect for their work, and there is one suggestion I may make: every commercial attaché in China (I refer here only to China) should be a triplet; in each year one of him should spend his time in the great treaty ports, including Hong Kong, studying primarily the questions affecting the import and export of commodities; one of him should be travelling continually through the interior studying the producing and consuming markets; one of him should be in England, in European countries, and in the United States, studying the production and sale of goods for the Chinese markets and the utilisation of Chinese produce, and in England giving addresses and holding conferences at industrial centres. In the second and third years each should move on to the next function. You may object that this will be expensive. You cannot make an omelette without breaking eggs; and if knowledge is worth having it is worth paying for.

One obstacle to your trade in general with your consuming markets, lies in your system (or no-system) of weights and measures, and your currency even is a difficulty in quoting prices. The metric weights and measures are universal except in the United States, China and Japan; and everywhere, except in the United States, currency, weights and measures are all based on a decimal notation (except that in China there are 16 ounces to the pound weight as in England). I only mention this subject, and suggest nothing in the way of a remedy—for England is very conservative.

Education.—Take the Chinese and educate them. You have in China a people naturally inclined to you. They have fought you as every other nation has, but they have the most friendly feeling to you; and you have only to encourage that feeling, not to create it. To-day, for the higher education, for university instruction and assimilation of thought, thousands of students go every year to Japan, because of propinquity in distance and in thought; hundreds every year to the United States, because they always have gone there and because special inducements are offered; some dozens come to England, attracted here by affinity, notwithstanding that there is nothing to invite them; and a few individuals used to go to France and Germany. Any expenditure to induce students to come to England will be amply repaid; to put it on the lowest basis, a mining engineer trained in England will be acquainted only with English engineers, methods and machinery—and orders will follow; a student in International Law educated in England will be more likely to take the British view of freedom of the seas.

Production.—I need not tell this audience that a country or a producer offering an article at twenty shillings will always lose his market to a competitor offering the same article of the same quality at nineteen shillings. In the past, with cheap coal, and cheap raw material, England has always maintained her foreign markets—what she has lost in one she has made up in another. Here is your chief danger in China. I do not fear high wages. High wages mean low labour cost—always on the supposition that, as in the United States, high wages give increased productivity. What I do fear is increased cost of raw material. In the past England was a creditor nation, drawing in her raw material from all the corners of the world on the most favourable terms, because the payment of the debts due to her created always rates of exchange in her favour, and because the outward cargoes of coal supplied tonnage to bring back return cargoes at low rates of freight. The creditor position has not been entirely destroyed, but it has been greatly weakened, and your raw materials will cost you more in the future. This creates a problem which will tax to their utmost the abilities of your economists—and it is one to be solved by them and not by the man in the street.

Advertising.—Find out the right way of advertising your wares to China. Here you draw a cheque in favour of an advertising agency, and he informs a credulous public that A's soap will wash everything except a conscience, or

that B's mixture is worth a guinea a bottle except for paying a bill. In China find out what kind of advertising is worth spending money on. Trade museums are good, if they are kept up-to-date; but travellers with samples are better, and one traveller might represent a dozen non-competing firms. Be liberal with samples. Mankind loves a free sample; I have had them thrust upon me—by representatives of American and German makers—and they brought orders. The Japanese system of packmen peddling through the country is one which it is not in your power to imitate.

Middlemen.—Whatever you may do with middlemen in other regions and in other respects, you cannot do without the middleman in China—the old-established firm, knowing the Chinese merchants and their ways, their solvency, and their requirements. Keep him going but supplement him, and stir him up to be modern. And be modern yourselves.

On this key I close—be up to date. Find out a good method for holding the China trade, and when found, make a note of it.

DISCUSSION.

The Chairman (Mr. Byron Brenan) said that all those who had listened to the paper must feel that they had a very clear vision of the history of the last three hundred years of trade in fragrant tea, clinging silk, soothing opium and aromatic spices, gradually changing into the more prosaic trade of to-day with such items as leather, soaps, salted fish and guano. The author had, with great dexterity, foreshortened for them the history of trade in the last three hundred years, and had then gently brought his listeners up to the present time, when daydreams had to be abandoned and stern realities faced. He had drawn a curve which connected the past with the present, and he left it to the practical man to project that curve, after making due allowance for disturbing factors, so as to enable him to foretell the future. If it was only possible to know what those disturbing factors were going to be it would be an easy matter. In the old days what could have been more simple, for example, than to load a ship with merchandise and silver dollars, cast anchor in the harbour of Canton, and gradually proceed to change the imported cargo into one of tea and silk for the return journey? But that was no longer possible. It may have been then extremely profitable for a few favoured ones, but now it was necessary to think of England with a much larger population and ever-increasing factories. After accompanying Dr. Morse through the three phases he had depicted so clearly, it was necessary to consider how Great Britain stood to-day *vis-à-vis* with China, when she had just emerged from a four years' war and was very eager to resume her commercial activity, and China was still engaged in a half-hearted civil war, but as keen as ever on business and very anxious to take advantage of everything with which nature had provided her. He proposed to say what, in his view, were the prospects of the future. Speaking in a very general way, the commercial relations of Great Britain with China now might be divided into three—first, the general exchange of ordinary articles of merchandise; secondly, providing China with modern methods for developing her industries and enabling her to undertake new ones; and, thirdly, that kind of work which was not usually undertaken by private individuals but more usually by the State, such as dockyards, arsenals, river conservancies, and big things of that kind. With regard to the first division, the modern merchant was not content to proceed upon the lines adopted by the old-fashioned merchants. In the not very far-distant years, the British merchant was quite content to stay in his counting-house and await the arrival of a customer. The more enterprising man now went forth himself and tried to find new customers and introduce new articles, and to look for produce which so far had not found a market in Europe. There were new fields for activities being opened up every day as railways and other means of communication were developed. It was inevitable, of course, that the Chinese by degrees should provide themselves with articles which, so far, Europe had supplied them with, because they had the raw material at hand and abundance of skilful craftsmen and cheap labour; but he thought it was not a matter for regret to see such changes, because it merely meant a diversion of money into other fields where Great Britain would have a fair chance of getting her share. He regarded with satisfaction any change which tended to enrich China. It was possible that certain individuals would lose, but that they must take as philosophically as possible because, on the whole, a rich China was so much to the good of this country; China could not become a prosperous country without Great Britain indirectly sharing in that prosperity. His second point had to do with trade in mechanical appliances which would enable China to improve her present industries or develop new ones. The trade in machinery was still quite in its infancy. The Chinese were perfectly willing to adopt new methods, and would take up anything if they were convinced it would be profitable and practicable. Between the originating of a new idea and its completion there was a certain period of time during which money had to be spent, and that was the difficult moment for the Chinese. He would leave it to the great manufacturers and financiers of this country to help China to tide over that period. There was a great field for electrical appliances and for machinery of every kind. His third division was one which would scarcely attract the individual firm or the single merchant; it contained matters that were undertaken by the State, and it implied a great deal of spade work,

expenditure of money, and patience. It was a field of operation with great possibilities; the reward was great, and it was worthy of serious consideration. Whenever a matter of great importance occurred, such for example as the security of the seas or the preventing of enemies landing on our shores, it was not left to each individual to take such steps as he thought best to meet the difficulty; the Government had considered all that and taken their own measures. Also, if a city with a large population found itself running short of water, it was not left to each person to take a can and get his supply, but the corporation, acting on behalf of the city, provided funds, found the source of the water and laid down the pipes. In view of the immense opportunities which were now being presented in China, why should not their great manufacturers, engineers and financiers all join hands, sinking their rivalry and competition, and work together towards one common object? It was not only that they would make money while they were doing so, but they would be preparing a wealthy and prosperous China, which would be a huge factor in future international trade. He thought the Federation of British Industries might take a few more steps upon the road leading to the promised land, a land which would most certainly be staked out by others if Great Britain let the opportunity go by.

Sir Charles Addis wished to acknowledge publicly the great debt due by the whole of the commercial community dealing with China to the author for the work he had done. This work would endure, and he had paid a compliment to all the Fellows of the Society in delivering his paper that evening. His narrative of the origin and development of Chinese foreign trade was curiously interesting and curiously disappointing. After half a century of free and open foreign intercourse it was really surprising that a people, sober, industrious, and intelligent, should care so little for the good and useful things which Great Britain was able to offer them, and that the expenditure of each unit of the population amounted to only a few shillings a year. No one could set foot in China without being struck with the extraordinary agricultural, commercial and industrial activity of the people. The waterways, the mountain paths, and every part of the country teemed with people making things for each other and exchanging them with each other; they were born merchants. The first and most obvious explanation of the slow progress of commerce with China was the Chinese self-sufficiency; the diversity of climate and the variety of production gave an importance to the internal trade which placed it beyond all competition with any foreign trade that China was likely to reach in the next century. There had been progress of a kind, and in spite of herself China was likely to be drawn more and more into intercourse with the West and into the exchanging of her products with the West. One of the great obstacles to foreign trade in China had been the enormous importance attached by the Chinese to agriculture. Even the modern educated Chinaman distrusted industrialism as he had seen it in his visits to Europe, and relished very little the idea that one of the concomitants of foreign trade, which was a tendency to stimulate industry in the country, should develop in China. It had been said continually that China was on the eve of very great developments, but those developments did not seem to mature. He would advise those who were engaged in trade with China to go step by step and to be a little cautious about hurrying the pace too much or encouraging any enterprise of which they had not well sounded the foundations. No doubt the merchant and the banker would be the better for being better informed. It was possible that some of the schemes for consulates or for commercial attachés might bear fruit, but he did not think there was any substitute for individual study, enterprise and initiative. Those were virtues which in a period of reconstruction might be overlooked. It might be that the modern merchant had been led to place his trust in outside things and not in the virtues which in the past had been so valuable to this country.

Sir Richard Dane, K.C.I.E., said the author had referred to the currency of China, and had said that the unit was a tael, or Chinese ounce of silver. That, however, was only true now to a very limited extent. When he went to China in 1913, to assist in reorganising the Salt Revenue Department, he found the Chinese were trying to publish such accounts as they published in dollars. The bankers assured him that the tael was the only thing that could possibly be recognised, and the Financial Secretary who came to the Salt Revenue Department from the Maritime Customs Department was also at first in favour of recognising only the tael. But inquiries went to show that, except in the North-Western provinces and in the Treaty Ports, where the banks recognised the tael, in nearly all business transactions where money was actually passed, the account was worked out from taels into dollars, and payment took place in dollars. Working on that basis, the Administration introduced a system by which the salt revenue was received in dollars, and any loss which was incurred in getting the money to Shanghai was written off as a loss in exchange. In Szechuan the Provincial Government minted dollars after the revolution 10 per cent. less in intrinsic value than the old dollars, and he found that in the province those dollars had exactly the same value as the old dollars and were exchanged for the same number of coppers, and produced also practically the same amount of taels in Shanghai. It showed that the Chinese people were very anxious indeed to have a dollar currency introduced. At the end of 1915 things seemed to be moving so fast that he sounded the foreign banks to see whether they would be prepared to accept a Chinese dollar as a dollar in every Treaty Port in

China without working out its value in taels; and he told them that if they could do it, he thought he could secure from the President the appointment of foreign Assay Masters who would guarantee that the dollar had the actual value it purported to represent; but there were difficulties, and the matter went no further. At present, owing to the disordered state of the country, any scheme of that sort had become impracticable. He thought the future of British trade lay in the co-operation of the British with the Chinese, and he believed the most effectual way of securing the co-operation of the Chinese was to teach them the English language. They were eager to learn it, and they learned it with great facility; and a Chinese who knew English was more likely to be on friendly terms with the English-speaking people than one who did not.

PROFESSOR C. A. MIDDLETON-SMITH said that for the last seven years he had been in the University of Hong Kong attempting to train young Chinese in applied science work, and every year he had been brought into contact with those Chinese his admiration and respect for them had increased. Yet, much as he liked them as individuals, he had found himself every year a little less confident in the future of those young men if they were left to themselves. The one thing that would have to happen in China was co-operation between the Chinese and the Anglo-Saxons. The Chinese took very kindly to machinery; the Cantonese was simply a born engineer, his mechanical ingenuity being equal to that of any mechanic he had seen in this country. He was convinced that China was about to change very much because of the applied science work that had been done. During the last five years there had been a change in the large industrial centres of Great Britain, and a remarkable revolution in workshop production; the workshops were full, and at present unable to take orders. But at some time or other they were bound to need orders from abroad, and just as they reconstructed themselves during the war to meet the menace of war, so he was sure their methods of trade would be so reconstructed as to embrace Asia, and especially China. Many of the great leaders of industry were making active preparations to go to the Far East, and the concerns those leaders represented were concerns with capital running into millions sterling. They had men going out to China now investigating the whole thing, and he was sure they would find a big market for their machinery there. There had been a change in China, too. In the old days the Chinese spent a great deal of money on crackers. They had now taken to electric light, and divided their surplus between crackers and electric light. In Shanghai the electric supply station would rank with those of cities such as Liverpool, and at the present time Shanghai was putting in one contract of 18,000 kw. The villages and towns were also demanding electric light. In the past the trade with China had been in tea and opium, and he was convinced that in a few years the trade would be in machinery, and would be enormously more important than it was at the present time. His whole desire was to train the Chinese to develop the resources of their own country, in which nature had been wonderfully kind to them, although they were astonishingly ignorant of them. But they had tremendous mineral and natural resources which could be utilised in connection with scientific work, and he might mention that during the war China sent large quantities of tungsten to this country. The Chinese were as idealistic as other people, and they wished to create a better China and to develop the natural resources of their country and raise the scale of living; and in doing that he believed they were in their small way helping not only China but the whole world.

MR. F. ANDERSON said that everyone connected with China was under a deep debt of gratitude to Mr. Morse, not only for his paper, but for all he had written on the subject of China in the past. One outstanding feature that had struck him in his experience of China was that foreign intercourse had been carried on with the goodwill of the Chinese people, but almost always with the continued opposition of the Government; and all the development that had taken place in Great Britain's foreign trade with China had been accomplished in the face of official opposition. Whether that official opposition would come to an end under the republic, or whatever form of Government was eventually adopted in China, remained to be seen; but at the present time he thought the people of China as a whole were exceedingly anxious to develop industries in a great many different forms. The fact that China generally was an agricultural country, and that the population was constantly increasing, meant that the struggle for existence as an agricultural country would be so great that it would eventually lead to internal complications if nothing was done to increase the opportunities of the population for employment other than agriculture. In that industrial development there would be very great and very rapid changes in China, if only the incubus of official interference could be overcome. There was no country in the whole world that had more coal than China, yet that coal had been kept under the ground for centuries, and was at the present moment very largely undeveloped—and the same applied to iron—not because the Chinese did not want to develop it, but because of the official interference with the private individual and the tendency of the officials to try to get as much as they could out of any new enterprise. The East, in that respect, might be a warning to Great Britain, because, as was well known, there was a tendency for the British Government to interfere more and more in trade. No interference by the State would ever be a satisfactory substitute for the initiative

of the private individual. Great Britain's position in China had been built up, not by officials, but by the British merchants, and he believed that the future success of Great Britain in China mainly depended upon her merchants. He had considered more than once whether advantage could not be taken of the present disturbance in currency matters to endeavour to come to some international agreement which would stabilise the metallic basis of the currency of the whole world. Silver was at an extraordinary rate now, and there was an extraordinary premium on gold, but it was a curious thing that the premium on gold was very little different from the premium on silver if we took 60*d*. per ounce—the old international standard price—as the par value of silver, the premium on both was roughly 25 per cent.—that was to say, the original parity of gold and silver was maintained to-day. If there was great industrial expansion in the East and the previous state of things was allowed to recur, if the tael went down to 2*s*. 4*d*. and the dollar to 1*s*. 7*d*., with Eastern wages paid at the depreciated ratio of pre-war days, China would be a far more serious competitor in the industrial production of the West than she would if the artificial advantage of depreciated exchange was not given, and if silver were re-established in its former position in international currency.

Mr. S. Barton said that without Dr. Morse's work British officials in China would be under a great handicap in doing their work, for he did not think anybody was capable of doing work properly in China, where a knowledge of the past was essential in order to understand the present, without a careful study of Dr. Morse's book. With regard to trade in China, the conditions were not what they were even six years ago, and it was impossible to form a correct estimate of the various panaceas which were being offered now for the improvement of trade in China without a knowledge of what China was to-day. Sir Richard Dane advocated teaching the Chinese English, and he was sure that everybody who had to deal with foreign-educated Chinese would agree that the Chinese student should be taught in China. The complement of teaching the Chinese English was to teach the Englishman Chinese, because the language was essential in organising trade in China. Firms who were going to send men out to China should see that they not only studied the language in China, but commenced to learn the language before they left this country. There were schools for British merchants in the principal Treaty Ports, and there was an institution in London which afforded opportunities for studying the language in this country.

Mr. Cecil A. V. Bowra thought the main reason why trade with China grew slowly was the political disorder of that country. There was no peace in China. The provinces were all more or less independent. Trade routes were interrupted, and the railroads were harried by troops. For any great growth in China a strong Government was needed, and order, and those things seemed to be as far away now as they were sixty years ago. It might, of course, be possible that the Chinese would bring about a better state of things themselves, but it might possibly be done by the League of Nations.

On the motion of the Chairman, a hearty vote of thanks was tendered to Mr. Morse for his paper.

The meeting then terminted.

SPANISH SWEET PEPPERS.

Spanish sweet peppers, or pimientos morrohos as they are known locally, are produced principally in the Provinces of Logrono, Lerida and Valencia. The principal canning factories are at Calahorra, in the Province of Logrono; Lerida, in the Province of the same name; and the port of Valencia, which is in the famous fruit belt of Spain. The highest grade peppers come from Valencia.

In recent years, writes the United States Consul at Barcelona, the peppers of Logrono have lost much of their sweet quality, largely owing to cross pollinisation with the ordinary strong variety grown in the near vicinity. Although the growers of this district have made, and are making, efforts to bring their product back to its former quality they have as yet been unable to do so.

The acreage planted in sweet peppers during the 1918 season was from one-third to one-half the usual amount. This was due to a variety of causes, the most important one being that lands which have heretofore been planted in sweet peppers are well adapted to the cultivation of sugar-beets. Since the price of sugar in Spain, as in all other European countries, has been so much higher during the war than in normal times, it is but natural that the growers should have turned to the cultivation of a crop which has a wider market and a higher price. Another reason is that the demand from the usual markets of both North and South America has been much less because of the higher cost of the delivered product in those places. This increased cost has been brought about by the unusual price of tin plate for cans and by increased ocean freight rates.

In addition to greatly reduced acreage, several other factors tended to curtail last year's crop, one being that the proper cultivation of the plants ordinarily demands a generous use of fertiliser, but for some years past very little has been used owing to its greatly increased cost and general scarcity.

Sweet peppers are picked and canned during the months of September, October and November. The harvest begins in the more southerly Province of Valencia and gradually proceeds northward as the season advances. The product is put up in tins of 280 grammes (9·88 ounces) and 550 grammes (19·4 ounces). The larger tins are packed 50 to the case and the smaller ones 100 to the case, so that a

case contains approximately the same amount, whether packed with small or large tins.

The production of canned sweet peppers last season was as follows: Valencia, 30,000 cases; Lerida, 30,000 cases; Calahorra, 25,000 cases. The production at other places brought the total to 100,000 cases. Shipment takes place from the ports of Barcelona and Valencia.

IRON ORE DEPOSITS IN CELEBES.

The discovery of very large iron-fields in the Middle Celebes, in what is known as the lake district, has created a stir in mining circles in Netherlands Indies, reports from Government investigators having confirmed the original reports.

According to a report by the United States Consul at Batavia, an exhaustive study has been made of the Larona district, which is situated near the outflow of the Towoeti Lake, at a height of about 980 ft. above sea-level, and at a distance of 12 to 18 miles from a point on the coast from which shipment may be made. The Larona field occupies a surface of approximately 2¾ square miles; the other fields in this district are either less important or less favourably situated for exploitation. Further investigation is to be made by the Government of iron-ore fields in other parts of the archipelago.

It is claimed that the Larona ore is similar to that of Cuba and the Philippines; with the exception of the chemical composition the physical properties of these ore beds are equal to the Cuban. The Larona is said to yield common iron ore, chrome iron, nickel, and manganese ore. The average standard of the ore is 49 or 50 per cent. metallic iron.

It is known that the quantity of iron ore in the Larona field is at least 5,000,000 tons of surface ore, and 155,000,000 tons of clay ore, a total of 160,000,000 tons; but the estimate may reach 7,000,000 tons of surface ore and 206,000,000 tons of clay ore, a total of 213,000,000 tons. The ore can be extracted easily and cheaply; the fields cover a large territory, but the ore does not run very deep, the layers extending not more than 39 to 46 ft. in depth.

Considerable study has been made by the Dutch engineers as to the working of these fields. It appears that two methods are open—the smelting of the ore by the carbonisation of coal, the coals of Ombilin and Lematan being quite well adapted for carbonisation, or by electrical smelting. The latter method is preferred, as it is believed that there is sufficient water-power in the neighbourhood of the ore beds, and the establishing of electrical machinery for the purpose can be done at a low cost. An examination of the water-power possibilities is being carried out. The reduction expedient, wood coal, which is necessary for electrical smelting, can be obtained in abundance near the ore-fields.

The question as to the part the Government will take in the exploitation of these iron deposits will be settled later, when all the facts are known, but it will no doubt retain certain rights, whether the fields are worked entirely by a private concern or in part by the Government.

NOTES ON BOOKS.

THE PHYSICAL CHEMISTRY OF THE PROTEINS. By T. Brailsford Robertson. New York and London (1918): Longman, Green & Co. 25s. net.

This handbook of 484 pages, written by one who has long been known as a leading investigator in biochemistry, arrives as a welcome addition to the chemist's books of reference, and, quite apart from this quiescent function, Dr. Robertson's volume may serve to infuse new thought and directive force into the minds of those laboratory workers who have too much settled down and established themselves in the notion that chemical definiteness is mainly to be conceded to such bodies as are crystalline, or have constant boiling point or fusion point.

A note in full consonance with the general tone of the work is prominently placed opposie the title-page—the reminder of Professor J. J. Thomson that "a theory of matter is rather a policy than a creed; its object is to connect or co-ordinate apparently diverse phenomena, and above all to suggest, stimulate and direct experiment." Here we have the soul or essence of Bacon's doctrine that an erroneous theory is far more conducive to truth than an empty or chaotic state of mind. During investigation the policy (or theory) changes frequently, and in this drift of policy we have the best progress.

Despite the fact that there are many colloids other than proteins, Dr. Robertson's volume is largely — by overlap — a treatise on some of the leading characteristics of colloids in general; more especially in certain broad aspects, such as molecular weight, catenary configuration of the molecule, multiple bacisity and acidity, also instability in aqueous solution. Turning to page 342, where opalescence and the Tyndall effect are considered, the opalescence of many colloid solutions is tentatively correlated to the grossness of the molecules themselves, but the author urges that this appears unlikely to be the case in solutions of proteins, there being good ground for believing that the smallest particlps capable of scattering light should have a diameter of from 5 to 10 $\mu\mu$. A study of casein, taken as an example, indicates that in solutions containing 10^{-5} equivalents of base per gramme of the protein, the molecular weight is about 17,600, which suggests approximately the empirical formula—

$$C_{777}\ H_{1241}\ N_{197}\ O_{250}\ S_4\ P_4.$$

A study on this basis suggests that a casein molecule must have a diameter of about $2{\cdot}4\ \mu\mu$, or approximately half the diameter of the smallest particle which can scatter light.

Among the interesting methods for distinguishing the various proteins is the determination of a "gold number" (p. 349). Sodium chloride precipitates colloidal gold, a reaction which is inhibited in varying degrees by the different proteids. On this may be based a volumetric method for distinguishing proteids, and a method applicable to the differential diagnosis of syphilitic sequelae in the cerebro-spinal fluid.

A long review would be largely a summary, and no short review can give a notion of the interest and importance of Dr. Robertson's "Physical Chemistry of the Proteins."

GENERAL NOTES.

Secondary Industries in New Zealand.—The *Board of Trade Journal* (November 20th) reviews the conclusions arrived at by a special committee, after touring the Dominion to ascertain the immediate possibilities of New Zealand's secondary industries. The Committee propose the establishment of a Board of Industries and Commerce and a Board of Science and Industry. The former, consisting of three members of wide business experience, would be empowered *inter alia* to engage in trade, investigate and control prices, prevent exploitation of the public and suppress profiteering, make advances to industrial and commercial concerns, and prevent unfair methods of competition. The Board would also be charged with the duty of investigating such matters as the encouragement, improvement, and extension of New Zealand industries and manufactures; markets outside the Dominion and the opening up of external trade generally; wages and social and industrial conditions; labour, employment, and unemployment. One of the chief functions of the other Board would be the consideration of all proposals for specific scientific researches. It would be able to create scholarships and to award bonuses and prizes "with the object of encouraging scientific and industrial research." Apparently New Zealand is the only Oversea dominion in which an organisation for research has not been provided since August, 1914.

Post-war Steamship Services.—Most of the principal steamship lines which ran services before the war from London, Liverpool, Glasgow, and other United Kingdom ports, to India and Ceylon, are well on the way to complete resumption. The extension of Australian, Canadian, and South African services to Indian and adjacent ports promises to be a feature of the early future. Competition for the Indian carrying trade will probably be keen when conditions have become more settled. Japanese shipowners seem to be alive to the possibilities of the future, and several steamer lines of that nationality serve Colombo and South Indian and, to an increasing extent, other ports of the Dependency as well, on their way to or from more distant destinations. American activities, of which so much has been heard of late, appear to be confined for the present to a few lines mainly from New York and the Atlantic ports. Among European Continental services to India, which are in course of revival, may be mentioned the French sailings from Marseilles *viâ* Suez, Swedish and Norwegian from various Scandinavian ports, and Spanish and Italian services.—*Board of Trade Journal.*

Fabric Construction and Design.—In memory of his son, Lieut. Harry Dent Crompton, fallen in the war, Mr. John Crompton, a member of the Council of the Textile Institute, has given a sum of £2,000, the annual revenue from the investment of which is to be devoted to the provision of awards to the designers and weavers of original cotton textile fabrics, designed and woven by themselves in technical colleges or weaving schools in the British Empire. One half of the fabrics sent in for competition must be manufactured entirely of cotton, but, at the option of the competitor, part or all of the remaining specimens may contain only 70 per cent. of cotton threads and 30 per cent. of threads of any other fibre. Any subject of the British Empire, irrespective of sex, who is a *bonâ fide* student at a technical school, college, or weaving school, shall be eligible to compete for the prizes, unless he or she has left the apprenticeship stage and become engaged in the profession of a designer for textiles; but any candidate to whom a prize of £20 or upwards has been awarded, will not be eligible to compete in any subsequent year. The prizes offered will be one of £25, £20, and £15 respectively, and five prizes of £5 each.

A New High-speed Steel. — The *Iron Age* mentions that chrobaltic alloy, a new high-speed steel, is being used as a substitute for tungsten and vanadium steel by a Chicago company in making milling cutters and other tools with multiple cutting edges. The castings are said to be non-rusting and acid-resisting. The steel may be hardened in oil or air, and the processes of annealing and re-hardening may be repeated without the steel losing any of its properties.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

December 10.—Sir Oliver Lodge, D.Sc., Sc.D., LL.D., F.R.S., "Some Possible Sources of Energy." (Trueman Wood Lecture.) The Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., D.Sc., F.R.S., will preside.

December 17. — Constantine Grunwald, late Chief of Intelligence Department, Russian Ministry of Trade and Industry, "The Present Economic Position of Russia, and some Aspects of its Future Development."

COLONIAL SECTION.

Tuesday afternoon, at 4.30 p.m. :—

DECEMBER 9.—SIR EDWARD DAVSON, President of the Associated West Indian Chambers of Commerce, "Problems of the West Indies." LIEUT.-COLONEL L. S. AMERY, M.P., Under-Secretary of State for the Colonies, will preside.

INDIAN SECTION.

At 4.30 p.m.

THURSDAY, DECEMBER 18.—P. J. HARTOG, C.I.E., M.A., Member of the Calcutta University Commission, 1917–1919, "Some Problems of Indian Education." The Right Hon. LORD MESTON, K.C.S.I., LL.D., will preside.

FRIDAY, JANUARY 2.—A. P. MORRIS, B.Sc., A.M.Inst.C.E., Provincial Art Officer, Burma, "Burmese Village Industries: their Present State and Possible Development."

Papers to be read after Christmas :—

AIR-COMMODORE EDWARD MAITLAND, C.M.G., D.S.O., "The Commercial Future of Airships."

SIDNEY PRESTON, C.I.E., "English Canals and Inland Waterways."

BRIGADIER-GENERAL SIR HENRY P. MAYBURY, K.C.M.G., C.B., M.Inst.C.E., "Road Transport."

CHARLES H. SHERRILL, "Stained Glass."

ALFRED E. HAYES, General Secretary, English Language Union, "The English Language and International Trade."

JAMES CURRIE, C.M.G., Ministry of Labour (Training Department), late Principal, Gordon Memorial College, Khartoum, "Industrial Training."

LADY INGLEFIELD, President, Buckinghamshire Lace Association (North Bucks and Bedfordshire), "The Hand-made Lace Industry."

WILLIAM JAMES GARNETT, First Secretary, H.B.M. Diplomatic Service, "Mongolia and Chinese Turkestan."

GRAILY HEWITT, "Rolls of Honour."

ALFRED H. POWELL, "Ancient Cottages and Modern Requirements." The Right Hon. EARL FERRERS will preside.

CHARLES CROWTHER, "The Arts and Crafts of Japan" (with examples from the author's private collection).

SIR CECIL HERTSLET, late H.M.B. Consul-General for Belgium, "The Ruin and Restoration of Belgium." EMILE CAMMAERTS will preside.

WILLIAM CRAMP, D.Sc., M.I.E.E., "Pneumatic Convoying Plants, with special reference to the Transport of Grain."

L. GASTER, "Industrial Lighting in its relation to Efficiency."

H. M. THORNTON, "Gas in relation to Industry and Housing."

LIEUT.-COMMANDER NORMAN WILKINSON, R.N.V.R., O.B.E., R.O.I., R.I., "Naval Camouflage."

BRIGADIER-GENERAL LORD MONTAGU OF BEAULIEU, C.S.I., "Roads and Transport in India."

SIR GEORGE CUNNINGHAM BUCHANAN, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

SIR JOHN HUBERT MARSHALL, C.I.E., M.A., Litt.D., F.S.A., Director-General of Archæology in India, "Recent Archæological Discoveries in India."

SIR VALENTINE CHIROL, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

SIR FRANCIS WATTS, K.C.M.G., D.Sc., Imperial Commissioner of Agriculture for the West Indies, "Tropical Departments of Agriculture, with special reference to the West Indies." LIEUT.-COLONEL SIR DAVID PRAIN, C.M.G., C.I.E., LL.D., F.R.S., Director of the Royal Botanic Gardens, Kew, will preside.

INDIAN SECTION.

At 4.30 p.m.

January 2, February 19, March 18, April 15, May 20.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m. :—

February 3, March 2, May 4.

CANTOR LECTURES.

Monday evenings, at 8 p.m. :—

JOHN THEODORE HEWITT, M.A., D.Sc., Ph.D., F.R.S., Emeritus Professor of Chemistry, East London College, "Synthetic Drugs." Three Lectures.

Syllabus.

LECTURE II.—DECEMBER 8.—Phenol, salicylic acid and related substances — Derivatives of aromatic amines and aminophenols, *e.g.* phenacetin —Compounds of heterocyclic structure, antipyrine, flavine, etc.

LECTURE III. — DECEMBER 15. — Modified alkaloids, *e.g.* heroin, euquinine—Organic compounds of arsenic (atoxyl, salvarsan), antimony, mercury and other metals—Conclusion.

CAPTAIN H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S., Fellow of Downing College, Cambridge, and formerly of the Royal Air Force, "Aircraft Photography in War and Peace." Three Lectures.

January 19, 26, February 2.

CHARLES FREDERICK CROSS, B.Sc., F.R.S., F.C.S., "Recent Research in Cellulose Industry." Three Lectures.

February 16, 23, March 1.

WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.

May 3, 10, 17.

JUVENILE LECTURES.

Wednesday afternoons, at 3 p.m.:—

LOUGHNAN PENDRED, M.I.Mech.E., Editor of *The Engineer*, "Railways and Engines."

January 7, 14.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DECEMBER 8...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor J. T. Hewitt, "Synthetic Drugs." (Lecture II.)

Victoria Institute, Central Buildings, Westminster, S.W., 4.30 p.m. Mr. A. W. Sutton, "The Ruined Cities of Palestine, East and West of the Jordan."

Alpine Club, 23, Savile-row, W., 8.30 p.m.

University of London, University College, Gower-street, W.C., 5 p.m. Mr. F. W. Thomas, "Comparative Philology." (Lecture III.)

5.30 p.m. Mr. H. D. Eberlein, "American Architecture during the 17th and 18th Centuries."

Farmers' Club, at the Surveyors' Institution, 12, Great George-street, S.W., 6 p.m. Sir Trustram Eve, "State Control and Agriculture."

Geographical Society, Kensington-gore, W., 5 p.m. Lieut.-Colonel W. J. Johnston, "The New One-inch and Quarter-inch Maps of the Ordnance Survey."

Mechanical Engineers, Institution of (Graduates' Association), Storey's-gate, S.W., 8 p.m. Mr. R. J. Glinn, "Large Boiler Units."

TUESDAY, DECEMBER 9...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Sir E. Davson, "Problems of the West Indies."

Electrical Engineers, Institution of (North-Eastern Centre), Armstrong College, Newcastle, 7.15 p.m. (North Midland Centre.) Midland Hotel, Bradford, 7 p.m. Discussion on "The Linking-up Report." (Scottish Centre.) 207, Bath-street, Glasgow, 7 p.m. Mr. J. M. Scott-Maxwell, "Scientific Works Management."

British Acetylene and Welding Association, The George and Vulture Tavern, St. Michael's-alley, Cornhill, E.C., 7.45 p.m. Mr. G. J. Stanfield, "The Electrolytic Productions of Oxygen."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Discussion on Mr. H. H. Gordon's lecture, "Some Aspects of Metropolitan Road and Rail Transit."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. H. F. Farmer, "The Carbro Process."

Anthropological Institute, 50, Great Russell-street, W.C., 8.15 p.m. Mr. J. H. Hulton, "Leopard Men of the Naga Hills."

Colonial Institute, Central Hall, Westminster, S.W., 8 p.m. Mr. G. H. Knibbs, "Statistics and National Dealing."

Marine Engineers, Institute of, The Minories, Tower-hill, E., 6.30 p.m. Discussion on papers, "History of the Steamship," and "Electrification of Ships."

WEDNESDAY, DECEMBER 10.—ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Trueman Wood Lecture.) Sir Oliver Lodge, "Some Possible Sources of Energy."

Aeronautical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. J. D. Worth, "Aircraft Undercarriages."

University of London, University College, Gower-street, W.C., 6.15 p.m. Mr. J. C. Stamp, "Fundamental Principles of Taxation in the Light of Modern Developments." (Lecture VI.)

Oriental Studies, School of, Finsbury-circus, E.C., 5 p.m. Mr. L. Binyon, "The Art of Asia. Lecture IV.—Chinese Art."

United Service Institution, Whitehall, S.W., 3 p.m. Rear-Admiral Sir W. E. Goodenough, "Light Cruisers."

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Dr. S. G. Moore, "Housing in relation to Maternity and Child Welfare."

THURSDAY, DECEMBER 11...Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. 1. Professor W. A. Herdman, "Notes on the Abundance of Marine Animals and a quantitative survey of their occurrence." 2. Mr. J. Brontë Gatenby, "The Fertilisation of the Calcareous Sponges."

University of London, University College, Gower-street, W.C., 5.30 p.m. Professor A. Cippico, "La Poesia di Giovanni-Pascoli." (Lecture VII., in Italian.)

Automobile Engineers, Institution of, 28, Victoria-street, S.W., 8 p.m. (Graduates' Section.) Discussion on "Worm versus Bevel Drive."

Optical Society, at the Chemical Society, Burlington House, W., 7.30 p.m.

Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Mr. J. M. Scott-Maxwell, "Scientific Works Management."

Historical Society, 22, Russell-square, W.C., 5 p.m. Dr. S. A. Khan, "The East India Trade in the 17th Century in its Political and Economic Aspects."

FRIDAY, DECEMBER 12...London Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. Hilaire Belloc, "The River of London."

Malacological Society, at the Linnean Society, Burlington House, W., 8 p.m.

Astronomical Society, Burlington House, 5 p.m.

University of London, University College, Gower-street, W.C., 8 p.m. Professor G. D. Hicks, "An Introduction to Modern Philosophical Thinking." (Lecture VI.)

Auctioneers and Estate Agents' Institute, 34, Russell-square, W.C., 7.45 p.m. Mr. S. A. Smith "Acquisition of Land (Assessment of Compensation Act, 1919)."

Sanitary Institute, 90, Buckingham Palace-road, S.W., 3 p.m. Dr. H. Scurfield, "Mothers' Pensions."

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NEXT WEEK.

MONDAY, DECEMBER 15th, at 8 p.m. (Cantor Lecture.) JOHN THEODORE HEWITT, M.A., D.Sc., Ph.D., F.R.S., Emeritus Professor of Chemistry, East London College, "Synthetic Drugs." (Lecture III.)

WEDNESDAY, DECEMBER 17th, at 4.30 p.m. (Ordinary Meeting.) CONSTANTINE GRUNWALD, late Chief of Intelligence Department, Russian Ministry of Trade and Industry, "The Present Economic Position of Russia, and some Aspects of its Future Development."

THURSDAY, DECEMBER 18th, at 4.30 p.m. (Indian Section.) P. J. HARTOG, C.I.E., M.A., Member of the Calcutta University Commission, 1917-1919, "Some Problems of Indian Education." The Right Hon. LORD MESTON, K.C.S.I., LL.D., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

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The lectures will be published in subsequent numbers of the *Journal*.

COLONIAL SECTION.

Tuesday afternoon, December 9th, 1919; LIEUT.-COLONEL L. S. AMERY, M.P., Under-Secretary of State for the Colonies, in the chair. A paper on "Problems of the West Indies" was read by SIR EDWARD DAVSON.

The paper and discussion will be published in the *Journal* of December 26th.

FOURTH ORDINARY MEETING.

Wednesday, December 10th, 1919; The Hon. SIR CHARLES ALGERNON PARSONS, K.C.B., LL.D., D.Sc., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Bassett, Frank Owen, London.
Bassett, John Harrold, London.
Clark, Victor Albert Jarvis, London.
Gaunt, Frederick William, Farsley, near Leeds.
Haas, Adolph Louis, A.M.I.Mech.E., London.
Hainsworth, Charles, Farsley, near Leeds.
Hargreaves, Miss Violet, Eccleshall, Staffs.
Holmes, H., Moseley, Birmingham.
Ibbotson, Walter Dudley Boswell, Bowdon, Cheshire.
Kay, Max M., Manchester.
Maurice, Ernest Maurice, London.
Russell, Captain Guy, London.
Salmon, Harry, West Hartlepool.
Smith, John, M.I.Mech.E., Edgbaston, Birmingham
Turner, Augustus, M.A., London.
Waite, David E., Palmer, Mass., U.S.A.
Whittaker, Cecil John, Sunderland.
Wilding, John, Shotton, Flint.

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Brocklebank, Captain H. Cyril R., R.N., O.B.E., Tarporley, Cheshire.
Croft, Albert John, Birmingham.
Dunning, Harold Frederick, London.
Grant, Gustavus John, Birmingham.
Mercer, Raymond G., Manchester.
Paxman, Edward Philip, Bournemouth.
Plant, A. Edmund, Poulton-le-fylde, Lancs.
Reed, T. A. Woolterton, London.
Saunders, Arthur D., Bexhill-on-Sea.
Skelley, Horatio Arthur, Hyde, Cheshire.

The Trueman Wood Lecture on "Sources of Power Known and Unknown" was delivered by SIR OLIVER LODGE, D.Sc., Sc.D., LL.D., F.R.S.

The lecture will be published in the next number of the *Journal*.

JUVENILE LECTURES.

The usual short course of lectures adapted to a juvenile audience will be delivered on Wednesday afternoons, January 7th and 14th, 1920, at 3 p.m., by Mr. Loughnan Pendred, M.I.Mech.E., Editor of *The Engineer*, on "Railways and Engines." The lectures will be fully illustrated with working models and lantern-slides.

Special tickets are required for these lectures. They can be obtained on application to the Secretary.

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PROCEEDINGS OF THE SOCIETY.

THIRD ORDINARY MEETING.

Wednesday, December 3rd, 1919; The Right Hon. Lord Lamington, G.C.M.G., G.C.I.E., in the chair.

The paper read was—

THE SEED-CRUSHING INDUSTRY.

By J. W. Pearson,
Chairman and Managing Director, The British Oil and Cake Mills, Ltd.

The seed-crushing trade is probably one of the oldest industries in the world, and yet, like many another whose importance has not always been fully realised from a national point of view, it was left for the outbreak of the most devastating war in history to bring about a recognition of its vital importance.

The earliest indications of the existence of seed-crushing as a trade may be traced to a period many years before Christ, and it is difficult to say which was the first of the three manufactured articles coupled together by the great Psalmist in his song of gratitude—"Bread to strengthen, wine to gladden the heart of man, and oil to make him of a cheerful countenance."

There is no doubt that wine and bread were for long a household production only and for personal use, but it is probable that the manufacture of oil was almost from the first carried on for purposes of barter, and it is, indeed, quite likely that commerce in oil was the first real trade of the world. The oil was, of course, the product of the olive, and in the first place was probably used for external application only. It is a moot point whether oil produced from the olive grown on the shores of the Mediterranean or from the coco-nut palm grown further East can claim the greater antiquity. At a later date its use as a foodstuff was recognised, and olive oil for human consumption very early became an article of every-day diet. For many centuries the business of crushing oilseeds was carried on from the point of view of oil production only. The residue was accounted of no value and thrown out as waste. It is only within comparatively recent years that a use for the dry residual product was found either as a fertiliser or as a feeding stuff. The story goes that a certain manufacturer, who had dumped his residue into an adjoining field, noticed the cattle that were engaged in the operation of turning the rude crushing-mill of those days eagerly feeding from the pile of refuse. Very little observation disclosed the fact that the consumption of this residue, far from being harmful, was apparently beneficial to the physical condition of the cattle, and thereafter the residue, or "cake," as it is termed, quickly obtained recognition as a cattle food of considerable value.

The earliest centre in Europe where seed-crushing may be considered to have become an established industry was Holland, where mills were originally erected to crush seeds grown locally. While there are indications of the existence of oil mills in England in the fifteenth century, the first authentic documentary records of any factory date back to the seventeenth century, and relate to a business at Evesham (now belonging to Messrs. Foster Brothers' branch of The British Oil and Cake Mills, Ltd.), and by the middle of the eighteenth century the trade had acquired considerable importance. The chief manufacturing centre in England has always been Hull, where the principal seeds crushed were the product of districts abutting upon the Baltic Sea, from which part of the world Hull was the most convenient port for consignment. At the time of the outbreak of war there were some sixty different firms engaged in the trade in Great Britain, ranging in importance from small country owners with a mill capacity of 5,000 tons of seed per annum, to the establishments of the British Oil and Cake Mills, Ltd., whose combined branches handle something like 45 per cent. of the entire industry. The importance of ensuring that oilseed factories should be kept fully at work during the war

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There is no doubt that wine and bread were for long a household production only and for personal use, but it is probable that the manufacture of oil was almost from the first carried on for purposes of barter, and it is, indeed, quite likely that commerce in oil was the first real trade of the world. The oil was, of course, the product of the olive, and in the first place was probably used for external application only. It is a moot point whether oil produced from the olive grown on the shores of the Mediterranean or from the coco-nut palm grown further East can claim the greater antiquity. At a later date its use as a foodstuff was recognised, and olive oil for human consumption very early became an article of every-day diet. For many centuries the business of crushing oilseeds was carried on from the point of view of oil production only. The residue was accounted of no value and thrown out as waste. It is only within comparatively recent years that a use for the dry residual product was found either as a fertiliser or as a feeding stuff. The story goes that a certain manufacturer, who had dumped his residue into an adjoining field, noticed the cattle that were engaged in the operation of turning the rude crushing-mill of those days eagerly feeding from the pile of refuse. Very little observation disclosed the fact that the consumption of this residue, far from being harmful, was apparently beneficial to the physical condition of the cattle, and thereafter the residue, or "cake," as it is termed, quickly obtained recognition as a cattle food of considerable value.

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was quickly recognised, but, curiously enough, it was in the first place at the instance of firms engaged in the soap trade, who pointed out that the supply of glycerine for the manufacture of explosives was dependent upon the maintenance of adequate supplies of oils for soap manufacture. It was therefore considered necessary to include the trade of seed-crushing in the group of "controlled industries" under the Ministry of Munitions. Later on, the other aspect of the trade became more dominant, and the importance of the mills as a source of food supply—firstly, for the production of edible oils required for the manufacture of margarine; and, secondly, for the cakes so necessary to the production of meat and milk—resulted in the transfer of control from the Ministry of Munitions to the Ministry of Food. While during the days of its early growth this trade was mostly centred at the principal shipping ports, Hull, London, and Liverpool, there has been a gradual extension of factories at the outports. To-day the centres of manufacture are Aberdeen, Bristol, Burntisland, Bridgwater, Colchester, Dundee, Gainsborough, Glasgow, Gloucester, Grimsby, Hertford, Hull, Ipswich, Kirkcaldy, Leith, London, Lincoln, Liverpool, Lynn, Manchester, Rochester, Selby, Southampton, Warrington, Weybridge. The reason of this change is fairly obvious, as, up to the middle of last century, the principal shipping lines from the countries of origin only visited the three chief ports, and the natural tendency was to create factories as near as possible to the point of arrival of these heavy goods, and where also the main centre of consumption for the oil product was close at hand. In those days the few country mills had to buy their seed in one of the three ports and tranship round the coast by small steamer. The cake was consumed in districts fairly adjacent to the country mill, but the oil, to a great extent, had to be returned again to Hull or London. With the improvement in shipping facilities the outports developed, and, in addition to a certain amount of regular liner traffic, it became possible to charter steamers with facilities to load to other direct ports on a basis that enabled supplies of raw material to be taken in almost as cheaply as the same goods could be purchased at Hull or London. Factories of considerable magnitude have sprung up at the principal outports above named, and while they still have to send away a large proportion of the oil, the fact of their proximity to the cake-consuming districts enables a very effective competition to be put up as against Hull and London.

I should like to divide this paper into three main sections, each of which may be shortly examined—viz., the materials, the plant, and the products.

The Materials.—I have already remarked that the first known source of oil was the olive or coco-nut, and it was not until somewhere about the sixteenth or seventeenth century that it became generally recognised that many other vegetable seeds and fruits might be used for the production of oils. It will, I think, be convenient to classify the range of oil-bearing seeds into two main groups—first, those that are rich in oil; and, second, those that are comparatively poor in oil. This classification is useful, not because there may follow any analysis as to the countries of origin, but rather because it distinguishes two broad groups of seeds—the one of which is used by millers whose main business is the production of cake, and the other by millers who are most concerned with the production of oil.

Incidentally it may be observed that the seeds described as rich in oil usually require to be treated in a different class of plant from that required for dealing with seeds described as comparatively poor in oil.

Without attempting to cover the whole of the range of oil-bearing seeds, the principal descriptions may be grouped on the following lines: Those rich in oil—that is to say, containing 45 per cent. of oil or over—comprise ground-nuts, sesame, castor, mowrah, copra, palm-kernels, the three former producing liquid oils and the three latter solid oils. The group less rich in oil—containing less than 45 per cent.—comprise linseed, cottonseed, niger-seed, poppyseed, rapeseed, and soya, all of which produce liquid oils.

The major portion of the oilseed crops of the world are produced within the British Empire, and it is interesting to note that while a few seeds, notably linseed, rapeseed, and sunflower-seed, are grown in the Temperate Zone, the remainder are grown almost exclusively in the Torrid Zone, and therefore have to be imported by Europe for consumption there. England grows no oilseed crops, and is therefore dependent upon import for the whole of her oil production; but the continent of Europe raises considerable quantities of linseed, rapeseed, poppy, and sunflower. The claim to regard the oilseed trade as one of the key industries of the country is surely established when due regard

is given to the huge quantities of oil required by the manufacturers of soap, paint, linoleum, varnish, lubricants, and burning oils, among the technical trades; and baking, frying cooking fat, and margarine manufacturers among the edible trades. The total consumption of oils for these purposes in Great Britain is estimated at 600,000 tons per annum.

As the world's requirements in oils and fats grow every day, the story of past development has been the loss to the technical manufacturer of one after another of his markets for cheap oils, in proportion as scientific achievement has enabled each in turn to be rendered suitable for the edible trades; so a substitute has always to be found to replace for the soap pan the oil now used for margarine. A multitude of varieties of less known oilseeds are found in the world in enormous quantity, but they are either in districts at present inaccessible, or else in a condition or form that renders them almost unserviceable; but there is little doubt that in years to come, with future scientific developments and treatment, these will take their place among the important sources of oil supply. I have in mind such articles as the cohune, coquilla, and coquita nuts, the fruits of some of the many varieties of palm which are found in enormous quantity in practically all the tropical countries, and kindred seeds and nuts which have as yet proved of little interest to the ordinary seed crusher, because the heavy shell in which the kernel is enclosed has up to the present offered almost insuperable difficulties in the way of cracking and effective separation of kernel from shell. Similarly, oiticicia, ucuhuba, and illipi, which, though rich in oil, present extraordinary difficulties both to the crusher and to the extractor on account of the physical constitution of the material itself, which, when crushed, becomes a clay-like mass from which the extraction of oil is exceedingly difficult, if not commercially impracticable. Similar difficulties were encountered in the early stages of treating many of the seeds which are now so well known and freely handled, and the foregoing varieties are mentioned merely to show that there is still great scope for the application of scientific knowledge and research to the methods and processes in use for the production of vegetable oils.

Upon the general method of purchase of the raw material perhaps one word should be said, as the business of importing oilseeds is generally regarded as a separate trade, and is only in a few instances handled directly by owners of oil mills. The business of the merchant shipper is to purchase the seed in the country of origin direct from the native grower, to arrange for its transport and shipment, and last, but by no means least, to make the necessary financial arrangements to cover the period during which the goods are in transit, as the shipper does not usually receive payment until arrival of his cargoes at their destination. Special organisations have been set up to deal with the weighing and sampling of the consignments on arrival, with an elaborate system of analysis and examination under which a certificate is issued for the joint purpose of both buyer and seller, declaring the true proportion of pure material in the parcel examined, and at the same time both the nature and percentage of any admixture of foreign matter. This system of purchase on analysis has undoubtedly contributed largely to the general improvement in both quality and condition of the merchandise brought to this country.

The Plant.—In the early days when the only oil produced was obtained from the olive, the process was comparatively simple. The original breaking plant was the horizontal stone, probably operated by two women sitting on opposite sides, similar to that employed for the grinding of corn into flour. The broken mass was removed from the stone, packed in canvas bags and subjected forthwith to pressure under a long plank used as a lever. The method adopted followed pretty closely that in use for pressing grapes in the manufacture of wine. I think the earliest allusion to the apparatus is to be found in the writings of Vitruvius in his chapter on "The Farm Buildings," round about 30 B.C., of which the following translation was made by William Wilkins in 1812:—

"The press room should be near the kitchen, for then it will be conveniently situated for the preparation of oil. The wine cellar should adjoin the press room, and have their windows facing the north; for if they were exposed to the sun, the wine would be affected by the heat and become vapid. The store rooms in which oil is kept should be made to face the south, so that they may receive their light from the warmer quarter of the heavens; because oil is injured if suffered to congeal, but tempered by exposure to a certain degree of heat. The size of these rooms must be proportioned to the produce of the olive and vineyards, and the number of casks which contain it. Every vessel containing twenty amphoræ will occupy four feet. If the presses be worked with levers and beams, without the aid of screws, the press room ought not to be less than forty feet long, in order to afford space for the action of the levers, nor should its

width be less than sixteen feet, for then those who are employed at the press will not have their operations obstructed through want of room. If it be necessary to have two presses, the width of the room should be twenty-four feet."

[Later references to similar plant may be found in Pliny's "Natural History of 77 A.D."]

The first improvement upon this lever press was the substitution of the wedge press, where horizontal pressure was applied by means of a wedge driven downwards at first by blows from a heavy hammer, and later by the fall of a mechanically-lifted weight—an apparatus similar in general principle to the pile-driving machine of the present day. The screw press in place of the wedge followed naturally, as also the substitution of a pair of revolving vertical stones for the old horizontal mill stone. With such appliances the output was naturally small, and oil-producing mills were only sparsely scattered here and there close to the seat of production of the raw material. It was not until about the year 1600 that seed crushing can be regarded as having become an established industry, when a considerable number of mills were known to be in operation in Holland.

It was in 1652 that Pascal discovered the law relating to the uniform distribution of pressure in a fluid upon which the principle of the present hydraulic press is based. It was not until nearly 150 years later that an English patent was taken out in the name of an engineer, Joseph Bramah, who in 1795 lodged a claim for a special method of application of water or other liquid pr ssure to various mechanical devices described, for the transmission and application of power in a form giving results superior to any obtained by methods then hitherto known. It was, however, his invention of the U-shaped leather packing which rendered this system really efficient, and this was undoubtedly the most important invention in the history of seed-crushing. It was this patent that formed the basis for the introduction of what is believed to be the first hydraulic press, manufactured about the year 1830 by the French engineer Chambauvet. This press had a ram of 16 centimetres diameter (about 6¼ in.), and was worked at a pressure of 60 kilos per square centimetre (about 853 lb. per square in.). Within a few years the use of accumulators for the distribution of pressure was discovered by the Lyonnese engineer Falquiere, who at the same time built presses of a larger and heavier patt rn, starting with rams of 220 millimetres (about 8¾ in.) and increasing by steps up to 320 millimetres (about 12½ in.), which he worked at a pressure of 210 kilos per square centimetre (about 2,987 lb. per square in.). It was no doubt the introduction of this system of hydraulic pressing that caused the enormous and rapid spread of the industry all over the world. In the early years of the nineteenth century there were many small factories sprinkled over England deriving their power frequently from windmills, operating plants which consisted of a set of preliminary breaking rollers, generally arranged in pairs of two horizontally, from which the first crushed seed was transferred to a pair of verti al edge stones, and thence to a kettle or open pan where the meal was cooked by the application of free steam. The prepared meal was thereafter filled into a small bag of canvas material which was placed between the plates of what is now known as the old-fashioned vertical box press, in which from four to five cakes were pressed at a time. The first important improvement was the introduction of the open press, which consists of a series of flat plates slightly hollowed at the centre to give a grip on the material and fitted to take sixteen cakes at one pressing. The small horizontal pair rolls gave way to a machine of much greater power, the present pattern usually consisting of a series of five rollers 4 ft. in length and about 18 in. in diameter, arranged vertically, which obviously handles a much greater volume of seed and treats it with much higher efficiency. The prepared meal, instead of being filled into a small bag, is moulded through an open frame on to a plain cloth wrapper, the ends of which are afterwards folded over the moulded cake to facilitate transfer to the plates of the hydraulic press, where a total pressure of about 300 tons is applied. The residual cake when withdrawn from the press is taken to the paring machine, which is simply a cutting knife arranged with a horizontal reciprocating motion in order that the rough oily edges may be removed and a symmetrical appearance obtained. Under modern conditions a unit of machinery consists of one set of rollers, one kettle or steam cooker with its moulding machine, one battery of four hydraulic presses fitted to take sixteen cakes each, hydraulic pumps, accumulator, and paring table. Each unit is operated by a squad of three men, who between them turn out cakes at the rate of 112 per hour. Under the most modern practice mills are arranged to contain eight to ten such units, and the latest arrangements adopt such devices as automatic moulding machines and automatic paring machines.

which enable one man to serve two or three batteries of presses instead of only one. This is the type of machinery most commonly used in England, and is conveniently adapted for the treatment of the group of seeds earlier described as comparatively poor in oil. A variation in this plant has been brought into use during the last half century, where a type of hydraulic press known as the cage press has been substituted for the open type. This is particularly adapted for the treatment of the seeds described as rich in oil, where the prepared meal spreads so rapidly under the influence of pressure that it cannot be retained between the plates of the open press. This type of cage press is built in barrel form of staves with minute apertures between each to permit the exudation of the oil. The moulded cakes are placed inside the barrel and submitted to hydraulic pressure, when the bulk of the oil is expressed. The residual cake is then usually withdrawn, re-ground, and submitted to further pressure in the ordinary type of open press. This is the class of plant that is most conveniently adapted for the treatment of such seeds as sesame, castor, ground-nuts, palm kernels, copra, mowrah, etc. Mechanical science is constantly on the alert for improvements in every section of machinery, but has for the most part confined its attention to the press. Several recent patterns are in more or less experimental use, although some—such as the Anderson expeller, which is really a horizontal barrel press relying upon the thrust of a screw with a gradually diminishing pitch to obtain the pressure necessary for the expulsion of oil; or the Schneider press, a similar pattern of barrel press arranged vertically and relying upon the thrust of a direct-acting piston against a thin film of material—have come into fairly extensive use for the preliminary pressing generally known as clodding.

No system has yet been discovered which will enable the whole process of oil manufacture to be conducted automatically from the cooking kettle to the point of oil expression, and this is the stage where there is much scope for economy in manufacture.

It is perhaps extraordinary that such an extensive operation as that of oil-milling can be conducted for such a comparatively low cost. In a well-appointed mill, on a pre-war basis, the whole operation of receiving, crushing, cooking, pressing, oil-filtering, and delivery of the produce, inclusive of interest on capital employed, depreciation, power, labour, consumption of stores, and all general working charges, could be carried out for less than £1 per ton, and this upon a raw material whose original average cost would not exceed £12 per ton.

In discussing plant in general use in oil mills, I must not omit mention of another system which for certain seeds has come much more into favour in recent years, viz., the process of chemical extraction. The plant here used is simply the application on a commercial scale of the same principles that are adopted in the laboratory for the extraction of oil from oilseeds when making an estimation of the contents. The preliminary treatment plant for breaking or crushing the material is similar to that adopted in hydraulic mills, but the crushed material is thereafter transferred to large pots or extractors, where it is subjected to the action of a chemical solvent, the ordinary forms of which are petroleum ether, carbon bisulphide, carbon tetrachloride and trichlorethylene. The first is in more general use, while all have certain advantages and disadvantages. In this process the residue is left in the form of meal and not in the form of cake, and one of the principal drawbacks is the difficulty of getting rid entirely of all traces of the solvent both in the meal residue and in the oil product. The process is in much more general use in North Europe than in England, because the farmers there are more accustomed to use feeding-stuffs in the form of meal, while in England the whole cake, bearing a brand, is generally preferred. In the oil there is frequently found a faint aroma from the solvent which is difficult to remove entirely in the process of refining. For a long time oil obtained by the extraction process was regarded as unsuitable for edible purposes, but improvements in the manufacture and purity of the solvent, and also in refining processes, now enable the oil to be used by almost all the edible trades.

In comparing the manufacturing costs of these two systems, the principal standing charges may be regarded as much the same for both, but while there is in favour of the extraction system a slight saving owing to the fact that no press bagging is used, there is a much greater coal consumption and a heavy additional charge owing to the loss of solvent, which is perhaps the most expensive item of the system. In normal pre-war days it was generally reckoned that the total manufacturing costs under the extraction process were at least 50 per cent. greater than those under the hydraulic system.

With this somewhat sketchy description of the machinery, a word on the process itself must be said. Roughly, the operation may be divided into five sections from the point of arrival of seed at the mill—cleaning, rolling, cooking, pressing, paring. While at first little attention was paid to the condition of the seed on arrival, modern mills now possess the latest machinery for screening and winnowing the seed as it passes through the warehouse. All the dust and extraneous admixture is removed by fans and sieves, so as to render the seed itself as pure commercially as possible before passing to the rolls. The rolling operation requires considerable attention and skill, as each kind of seed needs slightly different treatment. The object is so to crush the seed that every oil cell is bruised or fractured. The succeeding process in the hydraulic press will not avail to extract the oil unless the walls of the oil cells are properly broken down, hen e whole or partially crushed seeds passing through the rollers represent loss in oil to the crusher. On the other hand, over-rolling is an almost equal evil, as in such cases the oil cells are not only bruised and broken, but the whole mass is converted into a dough-like pulp from which the process of extracting the oil may be likened to the difficulty of squeezing water out of a soapy sponge. The cutting action which may be obtained by driving the rolls in surface contact at different speeds produces a gritty meal, and the skilled manager must learn to recognise the quality of texture of his rolled material that indicates sufficient bruising without over-treatment. The cooking process requires equal care. The seed is worked slowly round and round in the open pan or kettle, and subjected to the direct action of live steam, occasionally with the assistance of jacket heat. The temperature varies for different seeds, but is usually in the neighbourhood of 170°–180° F. The free steam, impinging upon the mass in the kettle, has the effect of not only raising the temperature and cooking the mass, but also of operating to expand and further break up the already fractured oil cells. The proper regulation of the kettle at this stage of the process ensures that while the dry meal is fed in at the top it shall travel round slowly with a corkscrew motion until, on reaching the bottom of the pan, the cooking process is exactly complete. The inflow at the top of dry meal and the draft from the bottom of properly cooked meal forms a perfectly continuous process. The presence of the steam also causes a certain amount of moisture to be absorbed by the meal. This has to be regulated to a nicety, as a given degree of moisture facilitates the expression of the oil, while even a slight excess substantially retards the operation.

Less individual skill is required in the pressing section. The principal point needing attention is the care with which each moulded cake is placed in exact position between the press plates—a fraction off the true line causing an alteration in the distribution of pressure on the surface of each cake, owing to the plates being hollowed in the centre. The even distribution of the mass of meal over the whole surface is of the greatest importance in securing regularity. Even with the most carefully prepared cakes there has been found a difference of nearly 4 per cent. in oil content between one corner of a cake and another. This is solely due to the difference in mass upon compression of the material. The pressure usually applied is about 1½ tons to the square inch in the press cylinder. With a 16-in. cylinder this gives a total pressure of some 300 tons distributed over the surface area of the cake, and works out at about 17 cwt. to the square inch on the cake surface, although some materials, such as palm-kernels, require much higher pressure. It has been found in practice, as already indicated, that the expression of oil depends more upon the previous careful preparation of the material than upon the actual pressure employed on the press.

The paring operation is necessary to complete the process, partly for the sake of symmetry in the finished article, but more particularly to trim off the oily sides and edges which exude under the influence of pressure applied in the press. Generally about 20 per cent. of the pressed cake has to be removed at this operation, and the oil contained in these oily edges when trimmed off will usually be about 20 per cent. As the usual object is to turn out a cake with an oil content of about from 5 per cent. to 10 per cent. average, the machines are carefully adjusted to remove just so much of the pressed cake as will exceed this figure and yet leave the maximum possible remainder for the sake of the output obtained. The parings are, of course, carefully ground up and returned to the kettle to be worked over again.

Each kind of seed requires individual treatment, and the quality of the finished product depends largely on the exercise of care and skill in selection, and cleanliness and regularity throughout the crushing process.

The Products.—It is in handling the products of the mills that the most interesting develop-

ments have taken place in recent years, more particularly perhaps as regards the oil product, as the great and increasing demand for oils and fats of all descriptions during the last century has been the reason for the large increase not only in quantity but in variety; indeed, many oils which less than a century ago had but little commercial value have now been brought into extensive use, not only for technical but also for the finest edible purposes.

The most important developments have been connected with the edible oil refineries. The earliest refiners confined their attention to the production of clear oil suitable for the manufacture of soap, and the main object was the removal of colour. This was usually done by subjecting the oil to a treatment of caustic soda or weak acid, after which filtration through an ordinary filter press completed the process. The plant was simple, consisting only of a series of open iron or lead-lined tanks. Oils intended to be used for edible purposes were at first treated in a very casual fashion, and for many years the only refining process used in England was the application of weak caustic soda for the purpose of neutralising the free fatty acids in the crude oil, followed by a steam and water wash and filtration over fullers-earth. This produced an oil which was ordinarily used for fish-frying and common cooking purposes. The development of refining plants made much more rapid progress in North Europe, where the use of oil for edible purposes was so much more general than in England. Here the prejudice of the Briton was so strongly in favour of butter, and so markedly averse to any vegetable substitute, whether described as margarine or sold under some other name, that the industry of producing margarine and other edible fats made but very slow headway in the United Kingdom, and there was consequently but little incentive for refiners to improve their methods. Here, again, the influence of the war has had a very marked effect upon the trade of this country. The consumption of margarine in England to-day is more than three times what it was at the outbreak of war, and the margarine manufacturing plants are now capable of producing over 10,000 tons of margarine per week, whereas not more than 2,000 tons were produced before the war. As a natural consequence, the extension of up-to-date refining plants has been rapid and marked. Numbers of refineries have sprung up in the different manufacturing centres, specially designed to produce what is known as deodorised oil. In these plants the crude oil is subjected first to treatment with a weak alkali for the purpose of completely neutralising the free fatty acids. The neutralised oil is then washed, cleaned, and dressed with steam and fullers-earth, and afterwards subjected to the action of super-heated steam under vacuum, in the course of which all objectionable vapours are distilled off, leaving a pale clear oil completely neutral in constitution and flavour. Perhaps the most fascinating of all the oils is that obtained from cottonseed, on account of the multiplicity of its sub-products. Here the crude oil is a dark blackish colour tinged with red. The colouring matter, to which the name gossypol has been given, is of a resinous nature, and, curiously enough, is not derived from the black fibrous shell of the seed, but is contained in a mass of small brown cells which persist through the whole body of the kernel. It combines readily with caustic soda, and is therefore removed in the same operation as the neutralisation of the fatty acids. In the case of most crude oils subjected to this process, the residue is a semi-soap commercially known as soap stock, and is an article readily sought for by the soap manufacturer. Cotton oil residue, however, containing the whole of the colouring matter, is quite useless for the manufacture of soap, and up to fifty years ago was regarded as waste product, and had to be thrown away as refuse. To-day it has a high value, and is subjected to a special process of distillation at a high temperature over a current of superheated steam. The fatty matters are distilled over as a light-coloured grease, and the residue left behind as a black pitch. The constitution of this pitch can be varied in the course of the distillation process, and turned out either as hard bright brittle pitch, used for the manufacture of the coarse waterproof wrapping in which cotton goods are exported, also for railway covers, black varnishes, etc., or, again, as rubber pitch or elastic pitch, used in the manufacture of cheap rubber substitutes and as an insulating material in electrical work. The grease is distilled over again several times, each operation raising the melting-point of the fatty acids, thus producing fine white grease suitable for soap and candle makers. It may also be pressed in hydraulic presses, turning out on the one hand fine oleines, and on the other hard white stearine cake valuable for the manufacture of soap or candles. Thus every ingredient of a once waste product is now turned to useful account.

Probably, however, the most interesting process of recent date is that known as the hardening or hydrogenating process, which enables most liquid oils to be turned into a solid substance almost indistinguishable from tallow, and relies in its operation upon a purely chemical change. All liquid oils contain a large proportion of unsaturated fatty acids, usually described as oleic, which by the absorption of two extra atoms of hydrogen are capable of conversion into stearic acid. While the unsaturated oleic acids retain the physical form of liquids, the saturated stearic acids containing their full complement of hydrogen have the form of solid waxes or tallows. The hydrogenating process is the result of an invention based upon the discovery of a system under which it was possible to introduce the necessary additional hydrogen to complete saturation. The plant is not dissimilar to that used in the deodorising and refining process, but in this case the neutralised oil, instead of being subjected to the operation of a passage of superheated steam, is exposed to a stream of heated hydrogen gas in the presence of a catalyst. The catalyst seems to be a perfectly neutral body, whose mere presence appears to facilitate the absorption by oleic acids of the extra hydrogen necessary to complete saturation, and without which no action takes place. The catalyst usually employed is very finely divided nickel. I doubt whether the exact action of the catalyst is yet clearly understood, because at the end of the process it apparently remains in exactly the same condition as at the commencement, subject only to a gradual loss of efficiency through oxidisation. Several large plants have been erected in England and in North Europe for the treatment of oil by the hydrogenating process, and the general effect is to enable liquid oils to be used by either soap makers or margarine makers in place of hard oils. In considering the world's supplies as a whole, the liquid oils are in much greater abundance than hard oils, but the latter, owing to their physical consistency and high melting-point, are urgently required by both the soap and margarine trades in order to enable their products to be turned out in such a condition as to remain solid even under fairly high temperatures. In consequence, these hard oils as a group have always commanded a premium of £10 to £15 per ton in the open market over the liquid oils. A process such as this, therefore, which enables liquid oils to be converted into hard at an expense that probably does not normally exceed £5 per ton, must surely in the future prove to be of inestimable benefit to the trade.

The enormous increase in margarine and edible fats manufactured in England has created a demand for fine edible oils far in excess of that which previously existed, and while in past years considerable quantities of the finer oils were manufactured in North Europe and shipped to England, it is hoped that the manufacture of these oils in England, being so largely the product of raw materials grown in our own Colonies, will be retained as a permanent trade for the United Kingdom.

The other product of seed crushing upon which a few words must be said is the residue or cake so largely used for cattle-feeding. The cakes most ordinarily produced in this country —*i.e.* linseed cake and cottonseed cake—are so well known as to need but few remarks. It is, perhaps, not generally recognised that cake as a feeding-stuff is not only a concentrated food but a cooked food. Its intrinsic value depends largely upon the extent of concentration, which varies entirely with the individual seed used. Up to the middle of the last century the production of feeding cake was looked upon in a very casual fashion, but little attention being paid to either purity or condition. To the farmer "oil cake" represented the product of a linseed mill, probably containing just such other added ingredients as it might suit the miller to introduce. Competition in the matter of price in the earlier years of last century resulted in a considerable amount of adulteration, and, indeed, as the bulk was sold under the generic term "oil-cake," there was little importance attached to the purity of the article. The earliest attempt made for the protection of the consumer was the passing of the Merchandise Marks Act in 1887, which provided that any statement made by way of trade mark or brand should be effective as a warranty of the truth of such statement. Up to that date most millers had been in the habit of branding their cakes "pure," and perhaps it says but little for the conscience of the traders of that day that, after the passing of the Act, the word "pure" disappeared from many well-known brands of cakes. This was followed by the first Fertilisers and Feeding Stuffs Act in 1893, which enacted that any feeding-stuff sold under a description implying manufacture from one substance or seed was warranted to be pure and manufactured from that substance only, unless otherwise declared at the time of sale. Thereafter a cake sold as

linseed cake had to be made from linseed only, and contain no extraneous admixture. A marked improvement took place from that time onwards; and the attention of seed crushers has been largely directed to the scientific aspect of cake manufacture. The consulting analysts to the several agricultural societies, and particularly the Royal Agricultural Society, were constantly reminding their farmer clients of the importance of ascertaining the chemical analysis of the feeding-stuffs they purchased. The presence of sand and the presence of excess moisture, weed seeds, and other extraneous matter, was continually pointed out, and for the crushing trade it must be said that an endeavour was made to bring their products up to the highest possible pitch of excellence. The present Fertilisers and Feeding Stuffs Act, passed in 1904, enforced for the first time upon the manufacturer an obligation to give a guarantee, within fairly broad limits, as to the chemical analysis of the article sold in its essential ingredients, but there still exists a considerable difference of opinion between manufacturers and scientists as to the commercial value of such analyses. As a general guide, a statement as to the contents of oil, albuminoids, carbo-hydrates, is undoubtedly useful, but there may be a tendency to place too much reliance upon the mere figure of the chemical analysis. Any practical farmer knows perfectly well that linseed oil is of much greater feeding value in cake than cotton or palm-kernel oil: or, again, that a unit of albuminoids in linseed cake or ground-nut cake is of much greater feeding value than a unit of albuminoids in cotton cake or rape cake, and yet for the purposes of chemical examination both rank as of the same value. By far the most popular cake in England is linseed cake, which shows no sign of being routed from its premier position even by the introduction of more modern articles such as sesame and ground-nut cake. Linseed cake serves an all-round purpose which is attained by no other, and may be used either as a fattener or a milk producer. For dairy purposes ground-nut cake and coco-nut cake have become exceedingly popular, and will become more so as the industry increases in England. The newer production, palm-kernel cake, is still a difficult market. It is unpleasant in the mouth, woody and unpalatable to both feel and taste. It is not consumed with relish by either cattle or sheep, and possibly the high proportion of fatty acids in the oil content may have something to do with its slightly unpalatable flavour. As a pig food it has always had an enormous outlet in Germany, and while its qualities in that direction have been demonstrated over and over again in the last few years, it still remains to be seen whether it will be able to oust barley-meal from its position as the pig-feeder's favourite when once the supplies of ordinary feeding-stuffs reach normal levels again. When properly ground there is no doubt as to the feeding value of palm-kernel cake, and great efforts will be made to extend its use in England in order to ensure that this country may be able to retain the palm-kernel crushing trade which has been carried on here during the last four or five years, and which previously was almost an entire monopoly for Germany.

A trade round which much debate has centred has been that of the production of cottonseed cake. The practice in England has differed from that in most other crushing centres of the world. The difference in systems is usually described as the production of decorticated cake or undecorticated cake. The American crusher decorticates the whole of his seed, crushing the kernel alone and producing thereby a cake rich in albuminoids and highly concentrated as a feeding-stuff. The shell, however, is largely wasted or has to be sold at a very low price. The practice in England has been to crush the whole seed at one operation, kernel and shell together. This system produces cake of lower value with a lesser degree of concentration, and consequently a more bulky feeding-stuff. It retains, however, certain astringent properties which are highly valued for use with the soft lush grass of this country as a sheep or cattle food, and when fed to grazing beasts it has no effective substitute. The result has been that a relatively higher price is paid here for undecorticated cake than for the decorticated, and consequently the American process has never found favour on this side.

The cake product of the oil mill is usually sold as a straight cake under the name of the seed from which it is made, thus: linseed cake, cotton cake, soya cake, etc. There is, however, an enormous business peculiar to this country in the production of a cake known as compound cake. This is cake manufactured from a selected mixture of straight cakes and other feeding ingredients such as treacle, locust beans, rice meal, millers' offals, etc., and has special advantages, more particularly for the small user. It claims to be a properly balanced food where the oil, albuminoids, and carbo-hydrates are

arranged in the most economical ratio either for fattening purposes or for milk production. The small farmer purchasing his linseed cake, cotton cake, or other straight cake separately, has to instruct his stock hand as to the proper proportions to mix for economical feeding, and he usually finds that the rough-and-ready weighing methods of his stockman are apt to result in either an inefficient or extravagant mixture. A properly balanced cake controls this matter effectively, and the importance of the point is quickly realised when it is recalled that a fair cake ration is 10 lb. per day per head of stock out of a total feed of abo it 50 lb. including bulk food, such as roots and hay.

Up to the outbreak of war the seed-crushing industry was carried on in this country principally for the sake of cake production, because as a nation we were a meat-consuming people, and the principal business of the miller was to provide material to enable the farmer to turn out meat and milk. On the other hand, the European seed-crusher was in business mainly as an oil producer. There the number of cattle fed bore a very different ratio to the human population, and it was the requirements in the shape of oil for direct use and for the manufacture of edible fats that was really the basis of the existence of the extensive co itinental oil-milling industry. It may be noted in passing that the continental miller was generally described under the title of "oil manufacturer," whilst in England he was known as a "cake manufacturer" or "seed crusher." This accounts for the fact that while England crushed mainly the seeds included in the group described as comparatively poor in oil, the European miller took the higher class of article such as palm-kernel, copra, ground-nut, etc. The last five years have brought about a substantial change in the English industry. Numbers of new plants have been erected whose major object is the production of oil, particularly for edible purposes and margarine manufacture, and this should mean a general expansion of the trade.

I have not touched upon many interesting problems connected with this business, such as the reason for oil appearing in certain vegetable seeds, when and whence it comes, why the divergence in quantity, or the extraordinary difference in character and constitution.

There is not scope within the limits of a paper such as this to do more than touch the fringe of so interesting and extensive a subject, but I venture to hope that I have been able both to indicate the need of continued scientific investigation and also to justify the claim of the seed-crushing trade to be regarded as one of the most important key-industries of the British Empire.

DISCUSSION.

MR. E. C. DE SEGUNDO said that in order to deal shortly with so vast and complex a subject as that of oil-seed crushing, not only a complete mastery of all its details was required, but also a happy selection of words. Having regard to the leading position which Mr. Pearson held amongst our great captains of industry, it was perhaps not to be wondered at that in the excellent *résumé* he had given to-day he should have shown himself to be possessed of those rare gifts in a marked degree. In his paper Mr. Pearson had referred to the process of transforming soft oils into hard oils or fats. He would like to ask some of the eminent chemists whom he saw present whether it was true that recent discoveries tended to show that there was a possibility of making the cycle reversible, or in other words of dehydrogenating the hydrogenated compound. If some process of that kind could be worked out commercially it would have a great influence on the future development of the seed-crushing industry. Dealing with the future of cotton seed as a raw material for the production of oil and cake, he said Mr. Pearson had referred in his paper to cotton-seed oil as the most fascinating of all the oils on account of the multiplicity of its sub-products. Mr. Pearson had dealt in detail with the by-products of the oil, and he (the speaker) had hung a diagram on the wall which showed a few of the more important products obtained from cotton seed, not only by the British method of crushing it whole, but also by the American method of decorticating the seed, extracting the kernel, and crushing the kernel only for oil. There were good and sufficient reasons, which it would take him too long to explain that afternoon, why the British manufacturers crushed their seed whole and did not follow the American method; it was not because they were behindhand in any way. Cotton seed could be roughly divided into two classes, the woolly and the bald varieties. The former comprised 95 per cent. of the seed produced per annum, so that the latter could, for the purposes of his remarks to-day, be neglected. Nearly all the woolly varieties were grown from upland American stock. The seed was first ginned, and then went through a second ginning process in what was called a saw linter, in which some of the longer residual cotton fibres were taken off and formed linters, from which various things were made. By using a recently-invented defibrating machine it had become possible to carry the removal of those residual fibres further, until the physical condition of the seed approximated to that of the bald seed, the material removed being termed "seed-lint." The British seed-crusher obtained

two products, oil and cake. The American produced three, namely, oil, hulls (the remains of the seeds after the kernels had been taken out) and decorticated cake (the remains of the kernel after expression of the oil). From the decorticated cake a flour was prepared in the United States containing about five times as much protein and fat as wheat flour and being practically starch-free. This cotton-seed flour constituted a valuable diluent for wheat flour. The little rolls exhibited were made from a mixture of about 6 per cent. cotton-seed flour and about 95 per cent. wheat flour. The "hulls" were now separated into their component parts of hull-fibre and shell-bran by a machine which had been introduced commercially only about two years before the war. The shell-bran formed the basis of the manufacture of many kinds of mixed food for cattle in the United States. "Linters," "seed-lint," and "hull-fibre" were all different grades or qualities of the residual fibre retained by the woolly cotton seed, and were all useful for the production of cellulose, which was the basis of a number of industries, such as the manufacture of paper, explosives, artificial silk, absorbent cotton, etc., etc. Mr. Pearson had very rightly pointed out in his paper that until recently the British seed-crusher was concerned mainly with the production of cake, and therefore his desideratum was a raw material, whether seed or nut, which contained not too large a proportion of oil. On the other hand, firms on the Continent for some years before the war had gone ahead with the manufacture of edible oils, and therefore sought out raw materials which gave a high percentage of oil. The war, among the many other changes which it had effected, had entirely revolutionised the ideas of British crushers with regard to the primary product of their plants, and they now used the richer oil-bearing seeds to an increasing extent, and would probably continue to do so. That change, however, would not put cotton seed in the background. Cotton seed was the inevitable concomitant of cotton cultivation. Professor Todd, one of the best known authorities on cotton, had said that a cumulative annual increase of from 800,000 tons to 1,000,000 bales of cotton was required to satisfy the world's requirements, so that they could look forward to a cumulative increase in the production of cotton seed. By the aid of the seed-defibrating machine which removed the short fibres without injury either to the fibres or to the seed, all varieties of woolly cotton seed were improved in value for the British crusher, and many varieties of cotton seed which were so heavily fibred as to be unsuitable for treatment in most British oil mills, could by defibration be converted into good merchantable seed. This, coupled with the successful application in industry of the residual fibres, put a different complexion upon the commercial value of the woolly varieties of cotton seed, which, by the exercise of proper care in selection, storing and shipping, might become a not unimportant factor in Imperial economics.

Mr. D. T. Chadwick (Indian Trade Commissioner) said that from the Indian point of view the most important point in the paper was the stress that was laid upon the fact that the British manufacturer was primarily a maker of cattle cake and not of oil. One result of that was that the Indian producer had to find a market for his richer oil seeds on the Continent, particularly in Germany and France; England neither wanted them nor bought them. He questioned Mr. Segundo's statement that cotton-seed oil was superior to all others for the production of margarine; ground-nut oils, coconut oil, and palm-kernel oil, must not be forgotten in that connection. He believed that in the original charter of the Tallow Chandlers' Company in the City of London the company were authorised to seize and destroy all adulterated oils. That was rather interesting in view of what Mr. Pearson had said about the measures that had been taken of late years to ensure the purity of the products of seed-crushing.

Dr. J. A. Voelcker said that while quite agreeing with Mr. de Segundo that a new era had come in the matter of crushing cotton seed, he should like to point out that the change had not been for the benefit of the British farmer. Whereas in the old days the farmer used to get genuine decorticated cake that had something like 16 per cent. of oil and perhaps 3 per cent. of husk, he now got a cake which was no better than the undecorticated variety, and which contained only about 5 per cent. of oil and something like 19 per cent. of undesirable fibre. Mr. Pearson had given a most interesting account of the improvements in the manufacture of oil, but while that was good in one direction it was not in another. It was good for the trade and the people who wanted the oil, but not for the farmer, because he got less oil left in his cake, and the better the pressing the worse the cake, although he had to pay as much for it as before. It was not quite true to say that no oil seeds were grown in England; especially since the war the growing of linseed—chiefly for the use of cattle—had been encouraged by the Board of Agriculture, and in Ireland considerable quantities were grown. Mustard seed was also largely grown in the eastern counties. He also could not agree that in the past the trade had been largely conducted for the benefit of the farmer; his experience was that oil was the chief consideration; the cake was considered as refuse, and the price the farmer had to pay for it largely depended on the price the crushers were getting for their oil. The war had brought home clearly the dependence of British people on fat being supplied to them in some form or other, and what was true for men was also true for cattle. All analytical chemists recognised the difference in the value of the oil and albuminoids according to the source from which they came, but the oil crushers and cake makers did not always recognise that. When dealing with linseed cake or cotton cake it was easy to say that

it was quite pure; but in a compound cake which was sold as containing so much oil and so much albuminoids, the oil might come from a variety of different sources, and it was necessary to pay particular attention to the sources from which the constituents were derived. He regretted the way in which cake manufacturers pushed their compound cakes; in his view they were merely devices to save the farmer trouble. If farmers made a scientific study of cattle-feeding, as they did in Germany, they could themselves do what the manufacturers were now doing for them. It was more important to know how the cakes were made up than to know that they contained so much oil, which might come from a very inferior source; but the makers still continued to guarantee the amount of oil content without any reference to the source from which it came.

Mr. H. J. Pooley said that although chemical extraction had been having rather a bad time lately, it was undoubtedly a coming process. He was sorry Mr. Pearson had not dwelt a little longer on extraction, and given them the benefit of his knowledge of some of its uses. For instance, it was very valuable in dealing with those materials the residue of which could not be used for cattle food, and for dealing with wood oils and those materials which could not be separated from the husk in a form which would enable them to be dealt with in the ordinary way. Extraction enabled all the oil to be got from materials of that kind. On the question of cost, Mr. Pearson said that the extraction process cost 50 per cent. more; but his own experience was that there was a difference in cost in favour of the extraction process of 2*s.* 6*d.* a ton.

Mr. J. E. Taylor, referring to the therapeutic value of cotton-seed flour, said that in the treatment of diabetes, chronic rheumatism, and in all cases where the uric acid diathesis was indicated, cotton-seed flour was undoubtedly beneficial, firstly on account of its proteid content. The proteid and fat content of cotton-seed flour was 60 per cent., and the carbo-hydrate content nil, which was a considerable advantage. Medical opinion differed as to whether it was advisable to give a preponderance of proteid matter in diet; but by using cotton-seed flour as an adjunct to ordinary flour the proteid was increased and the proportion of carbo-hydrates decreased, and consequently an admirable article of diet was secured. Cotton-seed flour was also very valuable both during and after the period of lactation; at least one well-known preparation on the market which had an extraordinary sale contained about 75 per cent. of cotton-seed flour. Cotton-seed meal, which was a cruder form, was equally valuable as a cattle food, and a friend of his who had experimented with it on British Friesian cattle had found that it increased their milk production by 10 per cent. Considerable quantities of that meal were used in Holland for that purpose, and it was interesting to know that the milk production in Holland was considerably greater per animal than was the case in this country.

Mr. F. J. Lloyd said he was consulting chemist to the British Dairy Farmers' Association, and dairy farmers were more interested in the cattle cakes produced in Great Britain than anyone else. He wished to warn cake-makers against a tendency which might prove very detrimental to the industry. When extracted meal was first introduced in Great Britain it was not successful, and after a time it was discovered that it was due to the fact that animals could not absorb the nitrogenous constituents of their food unless it also contained a fair amount of fat. No substitute for oats would ever be of value unless it contained as large a proportion of fat as was contained in oats. Linseed cake was especially valuable for two reasons; it contained more oil than most cakes, and was not hard. The tendency nowadays was to increase the amount of albuminoids and decrease the amount of oil in the cake, with the result that the albuminoids were wasted and not absorbed by the animal's body. Another tendency was to make the cake too hard, so that the animal could not digest it. The cake industry, if it wanted to succeed, must pay great attention to those two points, and produce a soft cake containing a large percentage of oil.

The Chairman (Lord Lamington) said he wished to express his gratitude to Mr. Pearson for having given them so very interesting a paper. What had impressed him most was the fact that the manufacturers were constantly on the alert to develop their industry and to find new processes. The British Oil and Cake Mills, Limited, of which Mr. Pearson was the head, did yeoman service during the war by building a number of different mills at the request of the Government for various processes—the extraction of glycerine and so on. He wished to thank Mr. Pearson very much indeed for his paper, and to congratulate him heartily.

Lord Lamington then left the meeting, the chair being taken by Dr. J. A. Voelcker.

Mr. A. W. MacIlwaine said he had been extracting oil for the last thirty-seven years by the so-called "chemical" process, which was really the physical process of dissolving out. He discovered about twenty-five years ago that the effect of the steam in the second part of the process was to destroy the poisonous ingredients in nearly all seeds. Mr. Pooley had said that castor residue was not fit for cattle food, but after it had been treated by steam he had found that was not the case. There was a great deal of prejudice amongst farmers against castor meal, so that he had not put it on to the market until the war began. Since then his firm had delivered between 1,000 and

2,000 tons for feeding purposes without there being a single instance of its having disagreed with the cattle. They claimed to have introduced a new cattle food which would be very valuable. Mr. Pearson had not mentioned the reason why in this country we had been behind the Germans before the war in the manufacture of edible oils. The main reason of that was because there was an import duty of £10 a ton on palm-kernel and other edible oils going into Germany. That enabled the Germans to over-bid this country in the purchase of raw materials on the West Coast of Africa. The war had changed that, and if German competition were re-introduced on similar lines he hoped a countervailing tax would be put on raw materials leaving the West Coast of Africa for Germany, in order to balance the German duty.

Mr. Walter F. Reid said the production of oil seeds in a scientific way so as to get the maximum amount of oil from a given area of land was a very important point. If farmers in England could develop that particular branch of agriculture larger quantities of oil might be grown in the country.

Replying to the discussion, Mr. Pearson said the reason English soap manufacturers had not made greater use of the rich seeds grown in India and elsewhere (a point to which Mr. Chadwick had drawn attention) was because in the past their plants had been designed to deal with those seeds which were least rich in oil, as they had regarded cake as their principal product. Now they had erected plant for dealing with the richer seeds he hoped they would be able to utilise the resources of the Indian Empire in those rich seeds to a greater extent. Referring to Dr. Voelcker's remarks on the subject of decorticated cake, he thoroughly sympathised with that gentleman. Owing to the form of contract adopted not being sufficiently rigid, a practice had grown up of mixing a little of the ground shell back again amongst the cake, with the result that the product on the market nowadays was really only semi-decorticated. With regard to the growing of oil seeds in England, the production in tons per annum did not run into more than five figures, which, compared with the enormous world production was insignificant. Dr. Voelcker's society had been the first to take steps to improve the quality of cakes, and in 1903 his (the speaker's) firm had adopted the practice of putting a label on their products certifying them to be pure within the terms of the guarantee recommended by the Royal Agricultural Society of England. As one of the leading manufacturers of those products in the country, he thought that guarantee was worth all the analyses put together. Although his firm were very large producers of compound cakes, he felt bound to endorse Dr. Voelcker's view that where a farmer had facilities for doing so it was to his advantage to buy "straight" cakes and mix them himself; but for small farms he thought there was much to be said for the compound cake. Mention had been made of the extraction process. It was undoubtedly of considerable value in dealing with those seeds the residue of which was of little value for feeding purposes; but for other seeds it was not very suitable, as it was important that a reasonable quantity of oil should be left in the residue for cattle feeding. He did not think, therefore, it would ever be used for linseed and cotton seeds and ground-nuts. With regard to the cost of the process, he had found that to be considerably more than 50 per cent. above that of the ordinary method of crushing. The difference between his figures and those of Mr. Pooley was probably due to the use of different methods of compilation. When the enormous extra cost in coal consumption, the loss of solvent, and other things, were considered, although there might be a saving in labour, it was evident that the aggregate cost of the extraction process must be considerably higher. He agreed with Mr. MacIlwaine that the fiscal systems of Continental countries had been largely responsible for the expansion of their edible oil trade.

A hearty vote of thanks having been accorded to Mr. Pearson, the meeting terminated.

GENERAL NOTE.

Science and Industry.—Signs are not wanting that the value of science to industry is becoming more widely recognised by employers, and numerous firms have made arrangements for the scientific instruction of their employees. A new departure in this direction has been inaugurated by the Anglo-Mexican Petroleum Company, who have arranged for the delivery of ten lectures to the staff by Mr. C. R. Darling, Lecturer in Physics, Finsbury Technical College, on the commercial applications of Physics. These lectures are intended to form a groundwork for specialised lectures to be given by experts connected with the Company, and to furnish a broad outlook on the subject of the application of science to industry. A lecture-room has been provided on the Company's premises at 16, Finsbury Circus, E.C., furnished with the necessary fittings for experimental demonstrations. The provision of a connected course of lectures of this kind is a novel feature, and should prove a valuable aid to any scheme of commercial scientific education.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoon, at 4.30 p.m. :—

December 17. — Constantine Grunwald, late Chief of Intelligence Department, Russian Ministry of Trade and Industry, "The Present

Economic Position of Russia, and some Aspects of its Future Development."

INDIAN SECTION.

At 4.30 p.m.

THURSDAY, DECEMBER 18.—P. J. HARTOG, C.I.E., M.A., Member of the Calcutta University Commission, 1917–1919, "Some Problems of Indian Education." The Right Hon. LORD MESTON, K.C.S.I., LL.D., will preside.

FRIDAY, JANUARY 2.—A. P. MORRIS, B.Sc., A.M.Inst.C.E., Provincial Art Officer, Burma, "Burmese Village Industries: their Present State and Possible Development." SIR HARVEY ADAMSON, K.C.S.I., M.A., LL.D., Lieutenant-Governor of Burma 1910–15, will preside.

Papers to be read after Christmas:—

AIR-COMMODORE EDWARD MAITLAND, C.M.G., D.S.O., "The Commercial Future of Airships."

SIDNEY PRESTON, C.I.E., "English Canals and Inland Waterways."

BRIGADIER-GENERAL SIR HENRY P. MAYBURY, K.C.M.G., C.B., M.Inst.C.E., "Road Transport."

CHARLES H. SHERRILL, "Stained Glass."

ALFRED E. HAYES, General Secretary, English Language Union, "The English Language and International Trade."

JAMES CURRIE, C.M.G., Ministry of Labour (Training Department), late Principal, Gordon Memorial College, Khartoum, "Industrial Training."

LADY INGLEFIELD, President, Buckinghamshire Lace Association (North Bucks and Bedfordshire), "The Hand-made Lace Industry."

WILLIAM JAMES GARNETT, First Secretary, H.B.M. Diplomatic Service, "Mongolia from the Commercial Point of View."

GRAILY HEWITT, "Rolls of Honour."

ALFRED H. POWELL, "Ancient Cottages and Modern Requirements." The Right Hon. EARL FERRERS will preside.

CHARLES CROWTHER, "The Arts and Crafts of Japan" (with examples from the author's private collection).

SIR CECIL HERTSLET, late H.M.B. Consul-General for Belgium, "The Ruin and Restoration of Belgium." EMILE CAMMAERTS will preside.

WILLIAM CRAMP, D.Sc., M.I.E.E., "Pneumatic Convoying Plants, with special reference to the Transport of Grain."

L. GASTER, "Industrial Lighting in its relation to Efficiency."

H. M. THORNTON, "Gas in relation to Industry and Housing."

LIEUT.-COMMANDER NORMAN WILKINSON, R.N.V.R., O.B.E., R.O.I., R.I., "Naval Camouflage."

BRIGADIER-GENERAL LORD MONTAGU OF BEAULIEU, C.S.I., "Roads and Transport in India."

SIR GEORGE CUNNINGHAM BUCHANAN, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

SIR JOHN HUBERT MARSHALL, C.I.E., M.A., Litt.D., F.S.A., Director-General of Archæology in India, "Recent Archæological Discoveries in India."

SIR VALENTINE CHIROL, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

SIR FRANCIS WATTS, K.C.M.G., D.Sc., Imperial Commissioner of Agriculture for the West Indies, "Tropical Departments of Agriculture, with special reference to the West Indies." LIEUT.-COLONEL SIR DAVID PRAIN, C.M.G., C.I.E., LL.D., F.R.S., Director of the Royal Botanic Gardens, Kew, will preside.

INDIAN SECTION.

At 4.30 p.m.

January 2, February 19, March 18, April 15, May 20.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

February 3, March 2, May 4.

CANTOR LECTURES.

Monday evenings, at 8 p.m.:—

JOHN THEODORE HEWITT, M.A., D.Sc., Ph.D., F.R.S., Emeritus Professor of Chemistry, East London College, "Synthetic Drugs." Three Lectures.

Syllabus.

LECTURE III. — DECEMBER 15. — Modified alkaloids, *e.g.* heroin, euquinine—Organic compounds of arsenic (atoxyl, salvarsan), antimony, mercury and other metals—Conclusion.

CAPTAIN H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S., Fellow of Downing College, Cambridge, and formerly of the Royal Air Force, "Aircraft Photography in War and Peace." Three Lectures.

January 19, 26, February 2.

CHARLES FREDERICK CROSS, B.Sc., F.R.S., F.C.S., "Recent Research in Cellulose Industry." Three Lectures.

February 16, 23, March 1.

WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.

May 3, 10, 17.

JUVENILE LECTURES.

Wednesday afternoons, at 3 p.m.:—

LOUGHNAN PENDRED, M.I.Mech.E., Editor of *The Engineer*, "Railways and Engines."

January 7, 14.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, DECEMBER 15...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Professor J. T. Hewitt, "Synthetic Drugs." (Lecture III.)

Faraday Society, at the Chemical Society, Burlington House, W., 7.30 p.m. Annual General Meeting. 8 p.m. 1. Lieut. W. A. Macfadyen, "Electrolytic Iron Deposition." 2. Mr. A. G. Tarrant, "The Measurement of Physical Properties at High Temperatures." 3. Mr. J. G. Williams, "The Electrolytic Formation of Perchlorate from Chlorate." 4. Professor A. W. Porter, "On the Vapour Pressures of Binary Mixtures." 5. Mr. Shinkichi Horiba, "Some Relations between the Solubilities of Solutes and their Molecular Volumes." 6. Dr. E. J. Hartung, (a) "An Accurate Method for the Determination of Vapour Pressure"; (b) "Some Properties of Copper Ferrocyanide." 7. Professor E. D. Campbell, "The Solution Theory of Steel and the Influence of Changes in Carbide Concentration on the Electrical Resistivity."

East India Association, 7A, Tothill-street, S.W., 3.45 p.m. Lieut.-Col. J. Shakespear, "Reflections on the Government of Wild Tribes on the North-Eastern Frontier of India."

Surveyors' Institution, 12, Great George-street, S.W., 8 p.m. Discussion on the President's Address on "The Future of the Institution."

Geographical Society, 135, New Bond-street, W., 8.30 p.m. Captain E. H. Keeling, "In Northern Anatolia, 1917."

Electrical Engineers, Institution of, at the Chartered Institute of Patent Agents, Staple Inn-buildings, Holborn, W.C., 7 p.m. Mr. R. Rankin, "Some Reflections on Labour."

TUESDAY, DECEMBER 16...Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.30 p.m. Mr. A. J. Wilson, "The Application of Liquid Fuel to Heavy Oil Engines."

Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Captain W. A. Howells, "The Art of Camouflage."

Electrical Engineers, Institution of (North-Western Centre), 17, Albert-square, Manchester, 7 p.m. Mr. J. M. Scott-Maxwell, "Scientific Works Management."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Major E. O. Henrici, "Precise Levelling."

Statistical Society, Adelphi Terrace, W.C., 5.15 p.m. Mr. J. E. Allen, "Some Changes in the Distribution of the National Income during the War."

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 7.30 p.m. Mr. G. Giles, "Kitchens and Bath-rooms."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Paper by Mr. N. E. Luboshez.

Colonial Institute, Central Hall, Westminster, S.W., 3.30 p.m. Professor C. A. Middleton Smith, "The British in the Far East."

Physical Society, Imperial College of Science, South Kensington, S.W., 2 p.m. Annual Exhibition.

Industrial League and Council, Council Chamber, Guildhall, E.C., 4.30 p.m. Lord Emmott, "Government Control and Industry."

WEDNESDAY, DECEMBER 17.—ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. C. Grunwald, "The Present Economic Position of Russia, and Some Aspects of its Future Development."

Central Asian Society, at the Royal Society, Burlington House, W., 4.30 p.m. Mr. M. Funduklian, "Armenia."

Electrical Engineers, Institution of (Wireless Section), at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Professor G. W. O. Howe, "High Frequency Resistance of Wires and Coils."

(South Midland Section.) The University, Birmingham, 7 p.m. Mr. J. M. Scott-Maxwell, "Scientific Works Management."

Meteorological Society, 70, Victoria-street, S.W., 5 p.m. 1. Mr. F. J. W. Whipple, "The Laws of Approach to the Geostrophic Wind." 2. Mr. G. M. B. Dobson, "Winds and Temperature Gradients in the Stratosphere." 3. Captain C. J. P. Cave, "Quotations from the Diary of Samuel Pepys on the Weather."

Geological Society, Burlington House, W., 5.30 p.m. 1. The Secretary of State for the Colonies' "Description of an Earthquake at Rabaul in May, 1919." 2. Mr. R. R. Lempriere, "The Raised Beach at South Hill (Jersey)." 3. Professor S. J. Shand, "A Rift-Valley in Western Persia."

United Service Institution, Whitehall, S.W., 3 p.m. Major-General Sir Lewis Jackson, "Possibilities of the Next War."

Oriental Studies, School of, Finsbury-circus, E.C., 5 p.m. Mr. L. Binyon, "The Art of Asia. Lecture V.—Japanese Art."

Public Health, Royal Institute of, 37, Russell-square, W.C., 4 p.m. Dr. I. C. Gibbon, "Housing and the Slum Problem."

THURSDAY, DECEMBER 18...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Mr. J. P. Hartog, "Some Problems of Indian Education."

Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Messrs. D. M. W. Hutchison and W. J. Wayte, "Electricity in Tin Mining."

(Irish Centre.) Royal College of Science, Dublin, 7 p.m. Mr. T. C. Roberts, "Water Power."

Royal Society, Burlington House, W., 4.30 p.m.

Chemical Society, Burlington House, W., 8 p.m. Professor J. Walker, "War Experiences in the Manufacture of Nitric Acid and the Recovery of Nitrous Fumes."

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, W., 5.30 p.m. Discussion on Mr. H. L. Sulman's paper, "A Contribution to the Study of Flotation."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 7.30 p.m. Mr. M. S. R. Adams, "The Use of Elliptical Vaulting as a Primary Factor in Contemporary Architecture."

Architects, Society of, 28, Bedford-square, W.C., 8 p.m. Professor H. Adams, "The Need for more Care in Warehouse Design."

FRIDAY, DECEMBER 19...Mechanical Engineers, Institution of, Storey's-gate, Westminster, S.W., 6 p.m. Mr. G. H. Burley, "The Cutting Power of Lathe Turning Tools." (Part II.)

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FRIDAY, DECEMBER 19, 1919.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

CANTOR LECTURE.

Monday evening, December 15th; DR. JOHN THEODORE HEWITT, F.R.S., Emeritus Professor of Chemistry, East London College, delivered the third and final lecture of his course on "Synthetic Drugs."

On the motion of the Chairman, DR. M. O. FORSTER, F.R.S., a vote of thanks was accorded to Professor Hewitt for his interesting course.

The lectures will be published in subsequent numbers of the *Journal*.

FIFTH ORDINARY MEETING.

Wednesday, December 17th, 1919; SIR HENRY TRUEMAN WOOD, Chairman of the Council, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Barnes, Jabez, J.P., Harrow.
Haigh, Bernard Parker, M.B.E., D.Sc., London.
Hammer, K. V., Christiania, Norway.
Horsnell, Daniel Thomas, M.I.Mech.E., M.I.Mar.E., London.
Howard, Henry Eliot, J.P., Stourport.
Jack, Robert Wilson, Girvan, N.B.
Kemp, Mrs. Mabel Amy, London.
Longstaff, Captain George William, R.A.F., London.
Mitchell, Harold F., London.
Mukharji, J., Srinagar, India.
Ogden, Alfred, Manchester.
Oldfield, Percy Jack, London.
Parsons, Robert Hodson, Assoc.M.Inst.C.E., Chingford.
Scott, James P., Birmingham.
Stuart, George Archibald Douglas, Bournemouth.
Tidswell, Mrs. Mary Florence, London.

The following candidates were balloted for and duly elected Fellows of the Society:—

Agar, Alfred, Belfast.
Barton, Alfred Danell, A.M.I.A.E., London.
Bishop, Edwin Kelsham, London.
Briggs, Roland Hunter, A.M.I.Mech.E., Harrow-on-the-Hill, Middlesex.
Britten, William Robert James, Horley, Surrey.
Brown, Alexander, Belfast.
Gill, Geoffrey M., London.
Gooby, Alfred H., London.
Hart, James Connorton, London.
Ide, H. W. F., London.
Longcroft, Cecil J., London.
Newnes, Sir Frank, Bt., London.
Pearson, John Westall, London.
Russell-Cotes, Sir Merton, J.P., Bournemouth.
Smout, Arthur John Griffiths, A.I.C., A.I.M.M., F.C.S., King's Heath, Birmingham.
Turrell, Frank William, King's Heath, Birmingham.

A paper on "The Present Economic Position of Russia, and some Aspects of its Future Development," was read by Mr. CONSTANTINE GRUNWALD, late Chief of Intelligence Department, Russian Ministry of Trade and Industry.

The paper and discussion will be published in a subsequent number of the *Journal*.

INDIAN SECTION.

Thursday afternoon, December 18th, 1919; The Right Hon. LORD MESTON, K.C.S.I., LL.D., in the chair. A paper on "Some Problems of Indian Education" was read by Mr. P. J. HARTOG, C.I.E., M.A., Member of the Calcutta University Commission.

The paper and discussion will be published in a subsequent number of the *Journal*.

JUVENILE LECTURES.

The usual short course of lectures adapted to a juvenile audience will be delivered on Wednesday afternoons, January 7th and 14th, 1920, at 3 p.m., by Mr. LOUGHNAN PENDRED, M.I.Mech.E., Editor of *The Engineer*, on "Railways and Engines." The lectures will be fully illustrated with working models and lantern-slides.

Special tickets are required for these lectures. They can be obtained on application to the Secretary.

A sufficient number of tickets to fill the room will be issued to Fellows in the order in which applications are received, and the issue will then be discontinued. Subject to these conditions, each Fellow is entitled to a ticket admitting two children and one adult. Fellows who desire tickets are requested to apply for them at once.

REPRINT OF CANTOR LECTURES.

The Cantor Lectures on "Coal and its Conservation," by WILLIAM ARTHUR BONE, D.Sc., Ph.D., F.R.S., Professor of Chemical Technology at the Imperial College of Science and Technology, have been reprinted from the *Journal*, and the pamphlet (price 1*s*. 6*d*.) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C. (2)

A full list of the lectures which have been published separately, and are still on sale, can also be obtained on application.

BOOKS OF TICKETS.

Every Fellow is entitled to admit two friends to the Meetings of the Society (with the exception of the Juvenile Lectures, for which special tickets are necessary). Books of tickets for this purpose can be obtained on application to the Secretary.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and copies can be obtained on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

FOURTH ORDINARY MEETING.

Wednesday, December 10th, 1919; The Hon. SIR CHARLES ALGERNON PARSONS, K.C.B., LL.D., D.Sc., F.R.S., Vice-President of the Society, in the chair.

THE CHAIRMAN, in introducing the lecturer, said that the subject of the paper was one that the war had emphasised as being of the greatest importance. Coal, water-power, and oil were at present our chief sources of energy; when they were exhausted, what would be the future of the human race? Sir Oliver Lodge would, he hoped, tell them of some other sources of energy which might be utilised in the future.

The lecture delivered was—

TRUEMAN WOOD LECTURE.

SOURCES OF POWER KNOWN AND UNKNOWN.

By SIR OLIVER LODGE, D.Sc., Sc.D., LL.D., F.R.S.

All that the human race can do in the material world is to move matter. To this end our muscles are designed, and only with their aid can we operate. Moreover, it is really through our muscles that we primarily enter into relation with the material world. Our muscular sense has informed us of the existence of an external world; it is that sense which enables us to interpret the indications of other senses, and which clearly discriminates "matter" from what might have been sensory illusion. All our physical activities may be summed up as the movement of matter: indeed, even our bodies are so composed, and are what we move in the first instance. The mind is in a different category, and when we think or will or remember, or suffer or enjoy, we are not necessarily moving matter; though usually some brain process accompanies these mental operations; but when a poet or a musician tries to express or record his thoughts, he has no other means available than to move a pen over paper, or work a violin bow or a keyboard, or of course he may set in action the muscles of his throat, and generate vibration in the air in that way.

That the whole function of an engineer is to move matter is fairly obvious. Civil engineers, in a spirit of inverted pride, sometimes denote themselves as "dirt-shifters"; but the construction of a bridge, or of an engine, or of a dynamo, can also be described as the shifting and placing together of material objects. The farmer and gardener again, do nothing else. All real operations, from the production of electrical currents to the growth of seeds, are performed by Nature. Locomotion, in one form or another, is the business of man.

Every form of physical activity requires power; hence power or energy is the most pressing material need of man. Food and fuel obviously belong to the same class; for whether the power exerted be directly muscular or indirectly mechanical, makes no difference in principle. Yet there is a difference. Food is mainly used by an animal for developing energy before it has assumed the form of heat. Fuel, unfortunately, at the present time, has to produce heat first, so that the heat can be

employed in some form of heat engine. We are thus up against the conception of temperature, and the inexorable law of efficiency, $\frac{T-T^1}{T}$. Heat can only be used when it falls in temperature from a hotter body to a cooler, and it is liable readily to fall in temperature without being utilised. When that happens there is loss of efficiency, and consequent waste of available power. A flagrant instance of fall of temperature with nothing to show for it, is the drop of temperature between furnace and boiler. All the heat may be transmitted through the walls of a perfect boiler, but it has become heat at a much lower level. The subsequent drop of temperature from boiler to condenser is utilised to the utmost by a multitude of ingenious devices, from Newcomen and Watt down to Sir Charles Parsons, whose engines I suppose utilise this fall of temperature in the most direct possible manner. But if the temperature of combustion could be made use of, as in a frictionless flame turbine, more of the fuel energy could be utilised. Internal-combustion engines attempt this, no doubt successfully up to a point; but so long as they require cooling jackets, whereby heat falls in temperature without doing work, so long they are imperfect Utilisation of undesired local heat to generate high pressure steam, would seem likely to be a step in the right direction, and an engine with flame on one side of the piston and steam on the other has become known.

But animals do not turn their food energy into heat at all—save what is needed for warmth. Nor does a voltaic battery turn its chemical energy into heat. Any heat produced is waste: the chemical energy ought to go direct into an electric current; and an electric motor is capable of utilising current energy very efficiently. Unfortunately, the chemicals are expensive, and it pays better to conduct electrochemical operations by aid of a dynamo and expenditure of mechanical energy, than to obtain mechanical energy from electrochemical operations.

It is important to realise that the law of efficiency $\frac{T-T^1}{T}$ is only applicable when the terms "heat" and "temperature" are applicable. The second law of thermodynamics refers to heat only, and not to any other form of energy. It does not apply to moving objects directly harnessed—like a fly-wheel; nor would it apply to molecules if their motion could be directly utilised. Organised and systematic motion is not "heat." In so far as the sun is a hot body, the formula is applicable, but it is a body at so excessive a temperature that the efficiency is nearly perfect. The fall of temperature from earth to absolute zero is 300°, but the fall from sun to earth is about 6000°, hence the efficiency is $\frac{6000}{6300}$, or $\frac{20}{21}$, or very nearly unity. The leaves of trees, and vegetables generally, are able therefore to absorb and utilise solar energy in the refined chemical operations needed for the production of wood and coal, as well as of food, and they seem able to do this without much regard to any hampering law of efficiency.

This is undoubtedly the best way of utilising present solar energy; and the moral is—promote Agriculture of every kind, and in the widest sense. The solar rays which fall on the sea are not wasted; they are needed for wind and rain, and they give us all our water-power, but solar rays fallen on barren soil or hopeless jungle are a reflection on humanity: that kind of waste ought not to occur. The progress of bacteriological science might make every soil fertile; even rocks can be dynamited into something; and jungles and swamps should be cleared. We are not living in the carboniferous epoch, and we cannot wait millions of years for the contemporary production of coal.

But it is not food and fuel alone that we get from the present-day sunshine: we get wind and water-power, too; and it is economical to use them where we can. The beauty of a waterfall is enticing, but looked at with an engineering eye many waterfalls suggest a sad waste of power. And even when there is not a waterfall, so called, all water in descending from high-level lakes to the sea must be able to give out power, which might be used wherever it is convenient to harness it.

In other ways the present sunshine may be utilised. I cannot regard with hope the idea of merely converting it into low-temperature boiler-heat. The barrenness of the Sahara would be the only excuse for the extensive use of burning-glasses or mirrors, and it is, perhaps, the only kind of place where such an enterprise could rationally be contemplated. But then there are very few parts of the Sahara where power is particularly wanted. Economy of transmission has a limit.

[A digression on the energy of the past sun may be permitted. All that the earth has caught, for all the millions of years that it has existed, is the merest fraction of what the sun has radiated in the same time. The earth

to the sun is like a printer's full stop at a distance of ten feet from a halfpenny. Some of the radiation from a globe one inch in diameter falls on the spot $\frac{1}{100}$ in. in diameter ten feet away, but that little speck only catches the hundred and fifty millionth part of the whole. What has become of the rest of the solar energy? It must still be careering through space. The ether is perfectly transparent, and only when it encounters matter will the radiation be mopped up and turned into heat. Not our sun only, but all the millions of other suns, have likewise been always pouring out radiation into space. Is there any hope of catching and utilising it? I trow not. In spite of all this constant flood of energy, space is cold; very near absolute zero. The reservoir is so enormous that all these taps, running for ages, have made no impression on it, have not raised the level a perceptible amount.]

The only portion of the past solar energy available to us is that which was caught and stored by vegetation. This it is which has produced combustible matter; this it is, probably, which has also liberated free oxygen into the air.

The amount of atmospheric oxygen, and the amount of combustible matter in the earth's crust, were believed by Lord Kelvin to correspond; one was the chemical equivalent of the other; they had been separated by solar radiation. If so, the amount of combustible matter, of every vegetable kind, in the earth's crust can be estimated; for it is easy to estimate the amount of oxygen in the air.

The amount of combustible matter is limited, but the oxygen of the atmosphere is also limited. We have not exhausted the total fuel supply as yet, and it is to be hoped that we never shall attempt it. It would be poor progress if the human race, in pursuit of mechanical activity, were to burn up the air it breathes. There is plenty left at present, but no thanks to human beings or animals that it is so. All our factories burn it up. Only vegetation restores and renews it. We used to burn up the air of our rooms in order to light them; we do better than that now. The utilisation of chemical or molecular energy seems necessarily limited. A great consumption of material yields comparatively little power. More plentiful and cleaner power is wanted. Some other source of energy ought to be discovered before the human race is a century older.

Are there any sources of energy not derived from the sun? Yes, two. The internal heat of the earth and the tides. Internal heat of some kind, whether due to radioactivity or otherwise, makes itself manifest in the neighbourhood of hot springs and volcanoes. The eminent Italian engineer Signor Luiggi Luigi has shown us how to bore into the bowels of Vesuvius and extract from it some of its energy in a practical manner. A remarkably interesting achievement!

The utilisation of the tides is continually being pressed by amateurs, but engineers rather take their stand with Lord Kelvin in recognising the extreme slowness of tidal operation. They realise the vast reservoir that would have to be filled and emptied every twelve hours, and how likely it is that the reclaimed land of the reservoirs would be of more value than the power; at least in any locality where the power was really wanted, without prohibitive distance of transmission.

The power of waves is different. That does come from the sun, and it is not leisurely like the tides. Those who have watched Atlantic rollers booming into creeks on the west coast of Ireland have felt that here surely was available power. We may imagine a Dreadnought (now let us hope of no further use) attached by a long girder to rack-work machinery, and being hoisted up and down by the waves. The weight that could thus be hoisted might be far greater than a Dreadnought—the whole German fleet for instance might be attached to the lever; it would give a good many foot-tons per minute; but whether any machinery would stand the strain I do not know. The idea is probably absurd, but it seems to me less problematical than the tides. Besides, in large harbours the tides are wanted for scouring purposes, and for clearing away a bar.

Is there any concealed store of energy recently discovered and not yet utilised? There is indeed. There are two,—one certain, the other rather hypothetical: the energy of the Atom, and the energy of the Ether. I propose to say nothing about etheric energy. If it exists, as I think it does, it is enormous, exceeding the bounds of imagination; but at present it is utterly beyond our reach. Atomic energy is rather inaccessible too, but not hopelessly so. It is far less in amount than etherial energy, but it is immense compared with any form of chemical or molecular energy, such as that derived from combustion or explosives.

By atomic energy I mean the constitutional

energy of an atom—the energy which makes it what it is. If this energy is given up in any considerable degree, the substance ceases to be what it was, and becomes a substance lower down in the scale. Utilisation of atomic energy would involve the stepping down, the degradation, of matter. The term is purely technical—it has been already applied to energy without moral stigma. All it means is that heavy atoms may become lighter atoms, and in so doing must give off a definite proportion of their great store of energy.

This spontaneously happens in the phenomenon known as radio-activity. If it had not spontaneously happened, we should have known nothing about the energy concealed in an atom. The explosive or radio-active atom has given the secret away. All atoms possess energy, but some cannot hold it all. These are the radio-active elements, and they periodically fire off projectiles with more than volcanic violence. A radium atom firing off a particle, which turns out to be a positively charged atom of helium, is like a two-ton gun firing a hundred-pound shot. That is about the actual proportion between the projectile and the rest of the atom; which naturally recoils each time it fires. The recoil has been observed. Before it has exhausted its ammunition it fires off five such projectiles, and then settles down into a quieter existence as lead—or, if not exactly lead, something chemically indistinguishable from lead. A uranium atom had already fired off four projectiles in order to become radium. Radium is a temporary half-way house between uranium and lead: it is active, but not so fiercely active as some of the intermediate substances, which last so short a time that they barely have names. They destroy themselves by their own activity, and consequently are very scarce—like a population with a high death-rate. Radium is of moderate activity; its lifetime is of the order a thousand years, whereas the lifetime of some of the intermediate substances may be measured in weeks or even minutes. Yet they are real elements, with a place in the series, and they have definite spectra and chemical properties.

Do not suppose that the well-known radium is an exceptional substance. It would seem that all substances of very high atomic weight are liable to behave in this way—it is only a question of degree. And it is not by any means their whole energy that they thus exhibit, it is the energy they expend and get rid of—their waste energy—which we perceive. And when we speak of their explosion, it is to be noted that the explosion is not a shattering or bursting of the gun, it is merely the firing of a shot; except that in the atomic case the shot was part of the gun. The energy retained is far more than the energy expended. And when its active transformations have ceased and left it in a stable state, like lead or gold or silver or copper or iron, or any common element, we are not to suppose that because it is quiescent therefore it has no store of internal energy. Appearances are deceptive. Anyone looking at cordite might think it harmless enough; and so it is till a suitable stimulus is applied. It does not go off spontaneously, or at least it is not wanted to. Gunpowder and any other explosive exhibits no trace of its secret to mere inspection; nor do the atoms of ordinary matter show that they are fearfully energetic; but the energy is there.

We may now go on to ask: What corresponds to the gunpowder, when I speak of a gun firing a shot? What propels the projectile? It is a very proper question, but at present it can only be partially answered.

There are two kinds of projectiles fired off by a substance—the heavy shot or α ray, which is known to be a helium atom, and the lighter shot or β ray, which is the fundamental unit of electricity, the negatively charged unit particle—an electron. Several electrons may be expelled, and they will not make much difference to the weight of substance left behind, but they will have left it positively charged; and in that case it is liable to fling away one of its massive positively charged particles, too. One event follows the other, and whether the electron always escapes first is uncertain. Whichever event procedes, in different cases, the other is likely to follow.

Many circumstances can stimulate the escape of an electron; not, indeed, of the deeper-seated constitutional electrons, but of the outlying superficial charges which are responsible for chemical affinity. Mere friction removes some of them, and leaves the substance positively charged. The removed electrons will have gone to the rubbing substance, and will have charged it negatively. Splashing of water, chemical action in innumerable forms, effects the transfer of electrons, and consequent charging of bodies. Ultra-violet light falling upon clear metal, and indeed upon a large variety of substances, causes electrons to be expelled, until the surface is positively charged enough to hold them back. The discharge will go on continuously if more are supplied from a battery. The jostling of the

molecules by heat will often cause electrons to escape, but not usually until a temperature of red or white heat is reached. Singularly enough, a comparatively low temperature will emit a few positive particles for a time; but this emanation soon ceases, the material gets tired as it were, and has to be re-born or renewed somehow, if the process is to be continued. Not so with the negative emission from hot bodies. This will go on as long as fresh particles are supplied.

In many ways, therefore, we can stimulate the escape of stray electrons, and it appears that by the aid of X-rays, or of projectiles from other atoms, we are beginning to learn how to disturb effectually, and even to eject, the deep-seated constitutional variety; though usually others immediately take the place of the ejected one, with consequent radiation of definite type. If a pair of β particles were permanently extruded, an α ray would probably follow, in order to restore the neutrality of the atom; and the atom would have gone a step down in the scale. This happens spontaneously, but the result of experience is that we cannot bring about the catastrophe by ordinary means. We cannot alter the spontaneous rate, by anything we as yet know how to do. Heating and cooling—alterations of molecular movement—seem impotent to get down to the inner mechanism. Still, we are certain that that inner mechanism is a most energetic system; and just as the internal charges are equally positive and negative, so I believe atomic energy is both static and kinetic—though perhaps not equally so.

The modern view of an atom is a central positive nucleus like a sun, and a revolving system of negative electrons like planets. The electric planetoids, so near this "sun," and subject to its powerful electrical attraction, must be revolving with prodigious speed, and with a frequency of orbital revolution exceeding in most instances even the frequency of light—a frequency only attained in general by the ultra-rapid X-rays. Accordingly, these little bodies have plenty of kinetic energy, and when they escape as β rays, they do so with something like the velocity of light.

The *frequencies* possible in a hydrogen atom turn out, in Bohr's theory, to be of the order 10^{16}, being either 10^{16} itself or else $\frac{1}{8}$ of 10^{16}, or $\frac{1}{27}$ of 10^{16}, the denominators being the natural cubes. For heavier kinds of atoms, this frequency must be multiplied by the square of the number allotted to the element in Mendelejeff's series.

The *diameters* of the orbits will be of the order 10^{-8} cm. divided by the atomic number and multiplied by the successive square numbers, 1, 4, 9, etc.

The *velocities* will be of the order 10^{8} cm. per second multiplied by the atomic number and divided by the natural numbers, 1, 2, 3, etc.

So for the heavy atoms, whose atomic number is approaching a century, the inner electron speeds are getting near to the velocity of light; hence probably their instability.

The positively charged nucleus is in different case. Its energy is more likely to be static, *i.e.* potential, like things held or caught together, as a detent may hold a strong spring. Let them be liberated, and they fly with great violence, presumably under electrical repulsion: the potential gradient near the nucleus is enormous, and the speed therefore very great, so that each atom where it strikes a zinc sulphide target makes a luminous splash. Taking the size of the nucleus as comparable to 10^{-12} cm., the acceleration of an α particle is Ne^2/Kmr^2 m being the mass of a helium atom; and this equals $3 \times 10^{26}N$ centimetres per second, at the start, and must be reduced to near zero at the confines of the atom. (N is thea tomic number.)

The projection of an α particle is therefore literally an explosion, and the force can very quickly get up an enormous speed. (The acceleration of a bullet in a rifle is comparable to 10^{7} or 10^{8} of the same units, at most.) The speed with which an α particle is ejected is about one-fifteenth that of light—sufficient to carry it to New York, if there were no obstruction, in a quarter of a second. Its energy is therefore, weight for weight, a million times that of a bullet. Only because an atom is so small does it fail to do any damage.

But the number of projectiles from a milligramme of radium is about thirty million a second; hence, in the aggregate, they generate a very perceptible amount of heat. We may not know the exact cause of their retention, or of their propulsion, but no one can deny that the energy is there. The main difficulty is to understand how they are retained and packed together into the exceedingly minute nucleus. The natural suggestion is that the cement consists of interleaved or interlocked negative electrons; and when these are dislodged by some perturbation from the orbital part of the atom, or by the impact of a projectile, the liberated positive particles are driven asunder.

As to the atoms' orbital electron energy, that is probably kinetic, they probably escape

with the velocity with which they were revolving in their orbits before perturbation. This is rendered plausible by the fact that their emission depends on synchronism between the periods of the particles and the X-ray disturbance which ejects them. Their energy of ejection is found to depend on the frequency of the radiation which stimulates it; a fact which at once suggests a storing of received synchronous vibrations, till a quantum of energy sufficient for ejection has been accumulated. Moreover, spectrum analysis of the derived or secondary X-rays, emitted by a substance exposed to radio-active bombardment, is also a test of the frequency of orbital revolution.

Particles can be ejected from one of several orbits—called respectively K or L or M, the K orbit being the nearest to the nucleus and therefore of highest frequency. Electrons are ejected at speeds still greater than α particles, and occasionally approach to within a few per cent. of the speed of light.

If we calculate the amount of energy thus quietly existing in the atoms of any visible piece of matter, we shall find it enormous. If each atom is the seat of these high velocities, and equivalent high explosive forces, the aggregate of energy in a few trillion atoms is very great; and it takes fully a trillion atoms to make a perceptible speck of matter.

To illustrate the energy possible in any reasonably small quantity of substance, it is sufficient to reckon the energy in a couple of grammes, or say thirty grains, of matter moving at one-tenth the speed of light. It need not be moving in the sense of locomotion; internal motion of its parts does just as well; and static energy can be equally well included, since its liberation will produce these high velocities. The energy is 10^{19} cgs. units or ergs. Now a foot-ton is 3×10^{10} ergs. Hence the energy of a few grammes of matter is three hundred million foot-tons, enough to raise a hundred thousand tons 3,000 ft. If all its parts were moving with the speed of light, the energy would be a hundred times greater, but it is doubtful whether bodies can move at quite the speed of light. For, just as a bullet cannot move quicker than a thermally modified velocity of sound, so a body is unlikely to move through the ether quicker than the ether disturbance can get out of the way.

No doubt a large store of energy is there; the practical question is, can we get at it and utilise it? We may even ask: Is any of it being utilised already? I do not think the answer is wholly in the negative; for that the activity of radium, thorium, and other radio-active substances, is employed therapeutically is well known. That was the beginning of practical application of the energy given off.

Atomic energy may unconsciously be being utilised in other ways, too. I have lately put forward an incipient radio-active theory of vision: I surmise that in the retina there must be a substance which can be stimulated into activity by the impact of ether waves of luminous frequency, that the substance then ejects a few of its outlying electrons, and that these stimulate the nerve-endings in their immediate neighbourhood. The way in which air vibrations stimulate the auditory nerve has been fairly made out; it is a question of mechanism; but the way an etherial vibration stimulates the optic nerve has not been made out: it is not a mechanical, but an electrical question. Radiation of high frequency is known to be received and stored until it is able to eject a negative particle with whose orbital frequency it happens to agree. And certainly such a particle when ejected could be depended on to stimulate a suitable nerve ending.

It is on those lines that I would explain the extraordinary sensitiveness of the eye. For the accumulation of a few million impulses would take no appreciable time, and it is difficult to suppose that in any other way than by synchronisation with some equally rapid intrinsic motion, could matter be perturbed by the extraordinarily rapid vibrations of ether—hundreds of millions of millions per second. Nothing larger than the ultimate elements of the atom could be expected to follow such rapidity. Molecules of matter would be almost too massive and gross to be readily moved as a whole; and, besides, their movement as a whole would only result in heat.

The same sort of idea could apply to the stimulus of a sensitive photographic plate; only here the chemical atoms are attuned, as a rule, to still higher rates of vibration, and are susceptible beyond the ultra violet, into the region of X and γ rays.

The facts of colour vision suggest that the visual substance (visual purple, or whatever it is) is specially sensitive to three particular frequencies, one in the red, one in the green, and one in the violet; but there must be plentiful overlapping, so that intermediate wave lengths may produce their full effect.

The whole idea at present is in the nascent stage: only it is instructive to think that possibly atomic energy may have been utilised

in the eyes of animals all the time. It is conceivable that it may have been utilised for the light emission of glow-worms, though that is generally and perhaps rightly considered to be due to molecular or chemical energy. Atomic energy is not chemical at all, but physical—at least, when the constitutional and not the outlying electrons are in question. It is possible that the absorption of solar energy by chlorophyll in plants may also in some way utilise atomic energy, stimulated into catastrophic activity by light waves. These things are only possibilities, which observers and experimenters may do well to follow up, and, if need be, negative.

But of late an application of atomic properties in vacuo has undoubtedly been made. Ordinary electric valves depend upon the different behaviour of positive and negative particles; and an electric bulb containing a positive electrode and a hot wire cathode was employed, some years ago, as a receiver for wireless telegraphy, by Professor J. A. Fleming. When the hot wire or filament is negatively charged, a stream of electrons reach the anode. When it is positively charged, the emission is checked. So if an alternating current is received, the emission of electrons is alternatively helped and hindered, and thus the current is rectified and made capable of being received by any ordinary instrument. The cutting up into signals has to be otherwise managed, for the alternations are too quick to be acoustically perceived.

Then Lee de Forrest introduced an improvement, and made it not only a wireless receiver but a relay or amplifier. Between negative filament and positive anode, in an exceptionally high vacuum, he placed a perforated grid or coiled wire, with interstices that would let the electrons through; and instead of applying the received alternating pulses to the anode, he applied them to the grid, placed above or facing the red-hot cathode, with the anode above or behind the grid. The effect on the escaping charged particles was the same,—the stream of current-carrying particles was helped or hindered, encouraged or stopped, as before; but now a strong battery could be applied between anode and cathode, and some mechanical receiving instrument, telephone or what not, could be placed in the auxiliary or relay circuit. Weak impulses applied to the grid, according to their positive or negative sign, will now serve to control the stronger current in the auxiliary circuit; and so a received message that in itself would be hardly audible can be magnified a hundred-fold.

Electrons emitted by a hot wire are not flung off with any prodigious speed: they seem rather to evaporate off at a red or white heat, and their subsequent course is controlled by the gradient of electrical potential in which they find themselves. The force acting on them is $F = edV/dx$, and the total work done is $Fdx = edV$; that is to say, the energy generated depends simply on the total drop of voltage through which they pass. Their speed is given by

$$\tfrac{1}{2} mv^2 = e\,(V - V^1),$$

and it is usually considered sufficient to specify the voltage through which they drop, as adequately representing their externally generated speed.

They come off with *some* velocity, however; call it u; but a small opposition voltage will suffice to quench this, as gravity quenches the speed of a cricket ball thrown vertically up, and sends it down again. So it is with the electrons from a hot wire. Any potential difference greater than $mu^2/2e$ will return it whence it came. One volt rise in potential would be able to quench a speed of 450 km. per second.

That, then, is what happens between grid and hot wire. If the grid potential is negative, and greater numerically than the minimum value, the stream of electrons from the hot wire is stopped and sent back: if the grid is positive, the speed upward of the electrons is encouraged. They shoot through the pores of the grid, they reach the anode above it, they establish connection and convey the current. The auxiliary circuit, between anode and hot wire, is completed by them, and the signal is given. But this only happens when the grid allows of their passage. If the potential of the grid is adverse they never pass through it at all, but just return depressed to the hot wire. Electric evaporation is checked, just as the evaporation of water is checked in a closed space, not because no particles spring out, but because an equal number are returned. A positive grid promotes evaporation, a negative grid checks it, an alternating grid causes an alternating stream to pass through it; and the electric stream can follow every minutest fluctuation; for electron inertia is as nothing, and they respond instantly to the slightest force.

To get quickness of response the projectiles must not be allowed to bombard other molecules, so as to ionise them and render the whole atmosphere conducting. For this ionisation would not subside instantaneously, and therefore the current would not be completely under control. To avoid ionisation by impact, the

reservoir must be very highly exhausted; the current ought to depend on the projectiles themselves, not on their secondary and adventitious effects.

It is to be noticed that the kind of electric emission from a hot wire differs greatly from that stimulated by ultra-violet light or X-rays. These vibratory agents dig right down into the constitution of the atom, and eject electrons whose orbital frequency agrees with their own. The "harder" the ray, that is, the higher the frequency of the impinging radiation, the higher the velocity of the ejected electron—evidently because one of the innermost orbits is then perturbed. For in inner orbits the speed must be high, in accordance with Kepler's third law. The orbital speed varies inversely with the square root of the radius of the orbit. And the more massive the nucleus the greater the speed necessary to balance the centripetal force.

But the jostling of atoms by heat produces no such deep-seated effects. The effect of heat in a metal is as if a kind of atmosphere or crowd of stray electrons evaporated and escaped. It is unlikely that the electrons in a metal are really loose, but some of them are so slightly attached as to be practically loose—readily passed from atom to atom in the process of conduction, and readily expelled under the irregular impulses of heat.

Whether heat is the best way of promoting this electronic emission may be doubted. It seems an extravagant method, analogous to employing an electro-magnet where a permanent magnet would do, or to supporting a roof by a jet of water. But the other kind of stimuli, such as those promoted by radioactivity or ultra-violet light, do not seem to generate the right kind of docile emission. The very high-speed electrons would require too much potential to hold them down. The speed of electrons ejected by X or γ rays is definite, and depends on the frequency of the rays; but the speed of emission of electrons from a hot body is indefinite and irregular, being distributed in accordance with Maxwell's law for a monatomic gas. Moreover, the escape through the skin of a metal is equivalent to an escape against a "contact" difference of potential; and thus, in some cases, the electrons may be said to ooze rather than to fly out, and to owe their subsequent speed entirely to the external potential gradient in which they find themselves.

That state of things would be quite convenient for wireless telegraphy, since they would then be still more readily under control. The skin retardation exerted by tungsten has been measured as 4·6 volts, unless I am mistaken.

To return to practical applications of these atomic properties—for it is atomic properties rather than atomic energy that is at present being utilised. Not only is it possible to employ a relay in the way described, for the emission and receipt of wireless waves, but one relay can be used to stimulate another; and this can be done several times in succession, and immense magnification attained; for the electric stream is so rapidly responsive and docile that it can follow fluctuations that no mechanical relay could possibly follow. The rapidity of signalling thus rendered possible in the Morse Code is surprising. Of course an automatic sender, and some form of chemical or quick-responding receiver, must be used; and then the message can be as rapid as one can speak. The words are spelt out, without abbreviation, in dots and dashes; and yet the words come on to the tape at three hundred a minute, five a second or thereabouts.

It is also becoming well-known that Morse signals need not be used, but that ordinary speech itself can be thus wirelessly but electrically transmitted, with quite good clearness of articulation. Every auditory frequency is slow compared with what the atomic projectiles can follow, hence every variety of speech-sounds, vowels and consonants, can be readily picked up and transmuted into electric fluctuations. This is done at the sending end, and the aerial accordingly emits waves, which, though they have their own electric rate of vibration, succeed one another in batches corresponding to the acoustic frequencies. At the receiving end the succession of waves are picked up by the aerial there, and once more converted back into telephonic speech through the medium of one or more valve relays and appropriate devices.

There are many details, and great ingenuity has been expended in bringing this method of wireless telephony to the perfection which it has thus far attained. The whole thing is most hopeful, and splendid work is being done at wireless research stations. (I have recently seen the Government one at Woolwich, under Colonel Cusins and a devoted staff of workers, and have gone over it with great admiration.)

The interest to us, here and now, is that it is by the harnessing and practical utilisation of purely atomic properties, that all this great advance in practical electrical engineering has been accomplished. The conclusion is inevitable that much more remains to be done.

The Chairman said it gave him the greatest pleasure to propose a hearty vote of thanks to Sir Oliver Lodge for his magnificent lecture, in which he had taken them from the infinitely great—from the energy poured into limitless space from thousands of suns some ten times the size of the sun they knew—to the infinitely small, the smallest known things that they could get any inkling of, with a structure as complex as that of the solar system. It was wonderful to think that all that knowledge had been gained during the past twenty years. Engineers saw plainly that there were other sources of energy besides coal and the burning up of the oxygen in the air which must be utilised. The utmost they could do at present was to utilise water-power, and that they did in a wasteful manner. In England it was specially incumbent upon them to devote their attention to that matter. Their coal supply was only 2½ per cent. of that of the world and their water-power not much more than 1 per cent. of the world's total water-power, and engineers felt that too much attention could not be devoted to those wonderful researches of which Sir Oliver Lodge had given them so marvellous a vista. They were all indebted to Sir Oliver for giving them so clear an insight into the world of the atom, and its possibilities in the future.

Sir Henry Trueman Wood said it afforded him much gratification to second the vote of thanks to Sir Oliver Lodge for the brilliant discourse to which they had just listened. He felt assured that this series of lectures, if they were continued as they had been begun by Sir Dugald Clerk, Sir Herbert Jackson and Sir Oliver Lodge, would aid the advance and the diffusion of knowledge, and would reflect credit on the Society. It was about forty years since he had first made the acquaintance of Sir Oliver Lodge. At that time they were both secretaries of different sections of the British Association. Professor Lodge was then one of the most promising young men of science, and now he was one of the most eminent men of science in the world. It was interesting to remember that the first public announcement of his researches into electrical waves was made in the room they were now in, when Sir Oliver was lecturing on the means of protecting buildings against lightning. Those researches he had later developed into the series of investigations in aerial telegraphy for which the Society a few months ago had had the pleasure of awarding him its Albert Medal. He (Sir Henry) had heard many lectures delivered before the Society, but never had he heard one more brilliant. The subject was one of extreme difficulty, but Sir Oliver Lodge had made its general principles intelligible to his audience, and that was the test of a good lecturer. He had very great pleasure in seconding the vote of thanks.

The vote of thanks was then put and carried by acclamation.

THE PERUVIAN RAILWAYS.

Peru consists of three distinct sections, each of which extends from the extreme northern part of the country to the extreme southern. The first of these sections is the narrow, western coastal belt, arid except for its numerous river valleys. These river valleys are the avenues by means of which civilisation is slowly pushing inland; a very large percentage of the white population live in them; the country's chief ports are situated at their mouths; they produce the country's foodstuffs; in short, they are the centres of the industrial and commercial life of Peru. The second distinct section is composed of the two and, sometimes, three ranges of the Andes, which reach some of their greatest heights in Peru. In the high Andean Plateau between these mountain ranges lies hidden the mineral wealth of the country. The third section consists of the eastern slope of the Andes, or the montana, as it is called—a wild jungle still unexplored, except along the upper Amazon and its tributaries. The principal product of this montana region is rubber, which is taken down the Amazon and exported through Brazil.

The impenetrability of the Peruvian Andes is directly responsible for the fact that Peru, with an area of nearly 700,000 square miles, has only 1,700 miles of railway, or about 2·5 miles of railway per thousand square miles of area. Indirectly, railway development has been retarded by other factors. More than half the population is Indian, and a very large percentage is illiterate; political unity has been lacking, and the Government has been involved in a long series of border disputes, which has kept the treasury drained.

According to a monograph on the Peruvian Railways, prepared by the Latin American Division of the United States Bureau of Foreign and Domestic Commerce, Peru does not possess, strictly speaking, a railway system. The railways are slowly pushing their way across the coastal belt, and already two lines—the Central and the Southern—scale the coastal mountain barrier and tap the mineral region of the Andean Plateau, but no railway has yet penetrated further east than this. The montana on the east of the Andes is unconnected with the coastal region on the west, except by difficult mountain trails over which transport is impracticable. There are only three short stretches of longitudinal railway in Peru—one in the southern part of the plateau section, one in the central part of the plateau section, and one from the port of Callao north along the coast. The ocean is still the only highway available for travel from north to south.

With the exceptions of the two lines which penetrate the Andean Plateau, and the three short stretches of longitudinal line, the railways now in operation are short, isolated lines, extending from Pacific ports short distances up the river valleys and have but a single function—the connection of

Name of Railway.	Terminals.	Length.	Gauge.	Chief Items of Export.	Equipment. Locomotives.	Passenger Carriages.	Goods Wagons.
		Kilometres.	Metres.		No.	No.	No.
Tumbes Railway	Pizarro to Tumbes	11	0·75	Petroleum	. .	. .	. .
Paita to Piura	Paita, up Chira Valley to Sullana; south to Piura Valley; down this valley to Piura	97	1·44	Cotton, Petroleum	6	7	43
Piura to Catacaos	Piura, down Piura Valley to Catacaos	10	0·75	Do.	3	11	14
Bayovar-Reventazon (private)	Bayovar to sulphur mines at Reventazon	48	1·00	Sulphur	2	. .	24
Pimentel-Chiclayo	Pimentel to towns of Chiclayo and Lambayeque	24	1·44	Rice	2	4	24
Eten, Chiclayo, Ferrenafe	Main line: Pimentel to Chiclayo, Lambayeque and Ferrenafe	43	1·44	Do.	8	15	80
	Branch: Chiclayo to Patapo	24	1·44	Do.	. .	. .	. .
	Branch: Pimentel to Pomalca	28	0·91	Do.	. .	. .	. .
Eten-Cayalti	Eten to Cayalti in Sana Valley	36	0·60	Do.	3	2	10
Pacasmayo Yonan	Main line: up the Jequetepeque Valley to Yonan and Chilete	104	1·44	Rice, fruit	. .	. .	. .
	Branch: North from Calasnique to Guadalupe	27	1·44	. .	. .	. .	. .
Huanchaco Tres Palos	Main line: Huanchaco north to Tres Palos	14	0·91	Sugar	2	1	22
	Branch: up Chicama Valley to Roma	54	0·91	Do.	. .	. .	. .
Trujillo Railway	Salaverry, north to Trujillo, Chicama, and Chocape, thence inland to Ascope	76	0·91	Do.	13	20	170
Chicama Pampas (private)	Chicama, up Chicama Valley to Pampas	45	0·91	Do.	. .	. .	. .
Trujillo-Laredo-Menocucho	Trujillo, up Santa Catalina Valley to Laredo Branch: Laredo to Menocucho.	25	0·91	Do.	(a)	(a)	(a)
Chimbote-Tablones	Chimbote, up Santa Valley, through Tablones to La Limona	104	1·00	Do.	3	3	24
Supe-Barranca Pativilca	Supe, north to Barranca in Supe Valley and to Pativilca in Pativilca Valley	12	0·60	Cotton, sugar	1	3	8
Rio Pativilca to Paramonga	Short extension to hacienda, Paramonga	7	1·00	. .	3	1	13
Supe-San Nicholas	Supe to hacienda of San Nicholas	6	1·00	. .	2	2	4
Reparticion to Alpas	. . . .	25	1·00	. .	. .	. .	. .
North-Western	Ancon, north to Huacho	141	0·91	. .	. .	. .	. .
	Up Huara Valley to Sayan	55	0·91	. .	. .	. .	. .
	Huacho to Port Huaral	1	0·91	. .	. .	. .	. .
	Port Huaral to Chancay	13	0·91	. .	. .	. .	. .
Playa Chica-Salinas (private)	Huacho to Salt Works	10	1·00	Salt	. .	. .	. .
Chancay-Papla (private)	Chancay, up Chancay Valley to hacienda of Papla	25	1·00	Cotton	4	5	24
Lima Railways Company	Callao to Lima and short branches from both cities	41	1·44	. .	20	38	300
Central	Callao, through Lima, up Rimac Valley and coastal mountain range to Oroya	222	1·44	Copper	55	62	520
	Oroya, south along Andean Plateau to Huancayo	124	1·44	. .	. .	. .	. .
	Ticlio, on Oroya section, to Morococha	15	1·44	. .	. .	. .	. .
	Lima, north along coast to Ancon	23	1·44	. .	. .	. .	. .
Cerro de Pasco	Oroya, north to copper-mines of Cerro de Pasco Company	175	1·44	Copper	10	7	230
Casapalca El Carmen (private)	El Carmen mines to station on Central	4	0·60	Do.	. .	. .	. .
Lima-Lurin	. . . .	30	1·44	. .	. .	. .	. .
Cerro Azul-Canete	. . . .	10	0·91	Cotton, sugar	5	4	93
Tambo de Mora-Chinca	. . . .	12	1·00	Cotton	2	3	8
Pisco-Ica	. . . .	74	1·44	Cotton, grapes	6	9	18
Southern	Mollendo, through Arequipa and Juliaca to Puno on Lake Titicaça	524	1·44	Wool, hides, minerals, sugar	50	41	347
	Juliaca north along Andean Plateau to Cuzco	340	1·44	. .	. .	. .	. .
Ensenada Pampa Blanca (private)	Ensenada Town on Southern to hacienda in Tambo Valley	20	0·75	. .	2	4	32
Ilo-Moquegua	Ilo, up Moquegua Valley to Moquegua Town	100	1·44	Wine, grapes, olives	3	3	3

(a) Included in Trujillo Railway.

interior points of a special river valley with its ocean port.

The following is a statement of the railways now in operation, together with a few details as to location, length, gauge, etc. Of the thirty-one lines mentioned, only nine are over 100 kilometres (kilometre = 0·621 mile) in length. Practically all of the railways begin at a Pacific port and follow the course of a river inland. The gauges vary from 0·61 metre to 1·44 metre. In every case the lines are dependent on the success of a few plantations or mines for the bulk of their export freight. The figures for equipment, which were purposely taken for a pre-war year, show the meagreness of the equipment of most of the lines even in normal times. (See Table, p. 75.)

In 1890 the entire foreign debt of Peru was taken over by the London Corporation of Foreign Bondholders, and in return the Peruvian Government granted that organisation certain concessions, including the control of all State railways, for a period of sixty-six years. The Peruvian Corporation was then created by the Corporation of Foreign Bondholders to administer these concessions. In 1907 a new contract was effected between the Peruvian Corporation and the Peruvian Government, by which certain disputes were adjusted and under which the railway lease was extended for an additional seventeen years.

The Peruvian Corporation controls some 1,300 miles of Peru's 1,700 miles of railways, including all the more inportant lines, with the exception of the Cerro de Pasco Railway.

The Government owns and operates on its own account three short lines, which have been built since the 1890 agreement—viz., Tumbes Railway, Ilo-Moquegua, and Lima-Lurin.

The Central Railway has well-equipped and up-to-date shops at Guadelupe, where necessary repairing is done, and also a small amount of new construction work. The Southern Railway has small but well-equipped repair shops at Arequipa. Native Indian labourers are successfully employed by both these organisations.

The Peruvian railways are not dependent on imported fuel as the Brazilian railways are, and hence have not been affected by the curtailment of the exports of coal from Europe and the United States since the beginning of the war, but the Peruvian railways had to face a fuel famine nevertheless.

The coal deposits at Jatunhussi, Oyon, Recuay, and other points are sufficient to supply Peru with all the fuel it needs, but these fields are still inaccessible and consequently undeveloped. The fuel for Peru's industrial establishments and railways is supplied by a single foreign corporation—the International Petroleum Corporation—whose holdings are near Tumbes, in the extreme northern corner of the country. As a result of a dispute between the Government and this Corporation, the tankers operating between Talara and the central and southern ports ceased running during last autumn. As the railways depend almost entirely on oil from Talara for fuel, and are equipped with oil-burning locomotives, the fuel shortage soon became acute.

In March of this year there were only three railway extensions actually under construction:—

Chimbote Railway	. Kilometre 104 to Recuay.
Central „	. South from Huancayo towards Ayacucho.
Southern „	. Cuzco towards Santa Ana.

The Recuay extension will tap an important coal deposit, which the Government is especially anxious to open up in view of the fuel shortage. The Huancayo-Ayacucho extension will make the coal deposits at Jatunhussi accessible, and will open up a country suitable for the raising of wheat and other grains. The Cuzco-Santa Ana line will be 168 kilometres in length when completed. It is a narrow-gauge line, and is estimated to cost £P500,000.

The plans of the Peruvian Government for a comprehensive railway system, which shall unite the east with the west and the north with the south, are slowly beginning to assume definite outline. These plans include two longitudinal railways, and one or more railways connecting the western coast with the navigable rivers of the eastern frontier. One of these longitudinal railways is to extend along the coastal belt, and will include the present line from Lima north to Huacho. The second will extend along the plateau section, and will include the lines from Cerro de Pasco south to Huancayo, and from Puno north to Cuzco. Three possible routes across the Andes have been discussed, but the route from Paita to the Rio Maranon and down the Maranon Valley is generally conceded to be the most practicable, and a decree authorising this railway, with extensions south to Ferrenafe and Hualgayoc, was issued towards the end of last year.

Among the extensions likely to be built in the near future may be mentioned the following: Sayan to the Oyon coal-fields, Chilete to Magdalena, Chuquicara towards Cajabamba. Government engineers have recently surveyed the last extension, which is part of the proposed longitudinal railway along the plateau, and have estimated the cost of construction.

The engineering difficulties and the almost prohibitive cost of construction have been directly responsible in the past for the slowness with which the railways have pushed up the river valleys, and preclude any chance of a rapid development in Peru such as seems likely to occur in Brazil. However, the hidden riches of the Peruvian Andes and the unknown riches of the plains beyond are bound to attract attention; while the Peruvian Government is on a sounder financial basis than formerly, and is anxious to weld the people, isolated in the various river valleys, into a united nation. Hence it seems probable that Peru will slowly push to realisation her dreams of a comprehensive railway system.

SOME CHINESE MANUFACTURED PRODUCTS OF INTEREST.

The following particulars regarding certain Chinese manufactures have been furnished to his Government by the United States Commercial Attaché at Peking :—

Dyestuffs.—Just before the outbreak of the war German synthetic indigo was imported into China to the extent of 10,000,000 taels a year, in addition to a large quantity of German aniline dyes. These had replaced in great measure the native vegetable dyes in which China was so rich ; in fact, indigo was no longer regarded as one of China's agricultural products. The native dye industry, however, by force of circumstances, has been revived, and dyes are now appearing in the list of exports.

Of first importance is indigo. It is grown quite generally throughout China for local purposes, but assumes greater importance in trade in the south. It appears that one acre of ground will produce about 6,000 lb. of indigo. According to tests made by the United States Bureau of Foreign and Domestic Commerce, the Chinese indigo contains only about 1 per cent. of pure indigo. Thus an acre will produce, with a good crop, about 60 lb. of pure indigo. The plants are cut before flowering, steeped in cold water for some days, and well stirred. After the plants are removed the water is again stirred, and slaked lime added to precipitate the dye. It 1917 China exported 78,148 piculs (picul equals 133⅓ lb.) of liquid indigo, valued at £142,000. In 1918 the figures were 83,642 piculs, valued at £183,000. Kiukiang and Swatow are the principal ports of export.

China's blacks are produced for the most part from gall-nuts, the fabrics having first to be dyed blue. The capsules of acorns are also used to produce black.

Yellow is produced from the flower buds of the locust tree (*Sophora japonica*), which are baked to a light brown colour, placed in cold water, and brought to the boil. Alum is used as a mordant. The powdered roots of *Curcuma longa*, or turmeric, are also used for a yellow dye, especially for cotton fabrics.

Red is produced from safflower, grown in Szechwan. Balsam (*Impatiens balsamina*), *Anchuse tinctoria*, and *Lawsonia alba* are also used, the latter to produce the rouge used by women. The *Rubic cordifolia*, a creeper, is used to make a deep red.

Green dyes for cotton cloth are produced from the bark of the *Rhamnus parvifolius*, found in Szechwan. Green dye is also made from the leaves of the *Rhamnus tinctorius* and other species of the buckthorn.

Brown dye is produced from the false gambier, grown extensively in south-western China. The darker browns are produced by the addition of gall-nuts and alum. A brown cloth that is very popular in the summer with the Chinese is a dyed grass cloth with a bright lustre and a waterproof appearance. Its distinctive qualities are the result of the dyes made from the false gambier.

The vegetable dyes of China are particularly well suited to Chinese rugs. These dyes will outlast the rugs. Exclusive of indigo, China exported nearly 2,000 tons of dyestuffs during 1917.

Fans.—China exports about 45,000,000 fans a year, mostly from Canton and Hangchow, the greater number being palm-leaf fans from Canton.

Fire-crackers.—China invented gunpowder and popularised fire-crackers. The cheapest kind of fire-cracker is made of gunpowder rolled up in coarse bamboo paper, with a covering of red paper, red being regarded by the Chinese as bringing good luck. Alum is used to neutralise the smoke. The Canton district is the centre of the industry. The Chinese seem to use fire-crackers upon every occasion—to speed a parting guest, in wedding celebrations, on festivals and birthdays, and to dispel evil and bring good omens. China exports about £600,000 worth a year.

Flour.—Before the war China imported large quantities of wheat flour from the United States. In fact, flour was one of the principal items in America's trade with China. High freight rates have prevented shipments of American flour to China, and now China has developed an export trade in this product. The 1917 Customs Returns show 47,500 tons (500,000 barrels) exported, more than half of which went to Russia. In 1918 the exports increased to 120,000 tons, of which more than half went to Great Britain.

There are 50 modern flour mills in China, including 15 at Shanghai, 9 at Harbin, and 7 at Hankow, the latter with an output of 1,600 barrels a day. Those at the three cities mentioned are the larger mills. The capacity of Chinese mills, exclusive of those in Manchuria, is estimated at 16,000 barrels a day. Harbin and North Manchuria produce 8,000 barrels a day. The development of the flour industry in China depends upon the development of transportation. It is safe, however, to predict that China will be able to supply its own needs in flour within the near future, if indeed it has not already done so. Manchuria and North China will offer splendid opportunities for the flour-milling industry.

Hats.—The manufacture of hats in China is certain to become an important industry. With the cutting of the queue foreign hats displaced the native styles. More than 2,000,000 rush hats are exported each year from Ningpo to the United States. A hat of good quality is being made in Szechwan of palm-leaf fibre. The extensive manufacture of straw braid in Shantung will lead to the manufacture of straw hats there.

Chinese Ink. — Chinese ink is sometimes erroneously called "India ink." It is made of the lampblack of sesame, rapeseed, or wood oil, to which is added varnish and pork fat. This paste is then mixed with glue, musk, or Baroos camphor to scent it, and some gold leaf to give it

a metallic lustre. It is pressed in carved wooden moulds, or beaten on wooden anvils with steel hammers, and then pressed into moulds. The best ink comes from wood-oil lampblack, collected on the sides of a second earthen jar placed above the one in which the oil is slowly burned. Anhui Province produces the best ink. There are many grades, the cheapest being produced from coarse soot and glue. China exported, during 1917, 116,000 lb. of Chinese ink, valued at 73,000 taels; in 1918, 127,000 lb., valued at 78,000 taels.

Lace.—Foreign missionaries in Chefoo, Shanghai, Foochow, Amoy, and Swatow have introduced lace-making among the Chinese women, and a considerable amount of lace has been exported from time to time. Silk, linen, and cotton threads are used in Chefoo, and linen and cotton in the other places. The lace is made more cheaply than is possible elsewhere because of the low wages paid in China, but a lack of enterprise in changing patterns to meet changing tastes and fashions abroad prevents the industry from assuming larger proportions. The exports, as shown by the Customs figures, amounted to 618,000 taels in 1917. In 1918 the figures reached 954,700 taels.

Mats and Matting.—At one time the making of mats and matting was an enormous industry among the peoples of the lowlands in southern Kwangtung, where the grass (*Arundo mitis*) was cultivated extensively. The seeds were planted in November and the reeds harvested in July and August. The fields are highly cultivated, and the grass grows from 5 ft. to 7 ft. high. The reed is three-cornered, and, after harvesting, is stripped and placed in the sun to dry. This work is done by women and children. When dried the strips are bundled into bales of 1 picul in weight, and disposed of in the market. For manufacture the grass is carefully sorted for quality and size. The dyeing is done before the weaving. The native loom is crude, and accounts in a measure for the lack of necessary development in the industry to keep pace with changing demands in the foreign markets. During the last ten years Japanese matting and mats have competed severely with the Canton products in the American market. The Japanese articles were better suited to the American demands, and the Canton industry was not prepared to adjust itself to the changes. Furthermore, with the war came a shortage of dyes and high freight rates, which affected the Canton industry far more seriously than they did the Japanese industry, which can depend upon Government assistance, especially in obtaining cargo space at reasonable rates. Prior to 1908 Canton exported 500,000 rolls of matting annually; in 1917 the exports were only 72,000 rolls; and in 1918, 52,000 rolls.

Medicines.—The materia medica of China is very rich. A nation with a civilisation dating back 4,000 years could hardly have done otherwise than develop a considerable number of products efficacious in combating disease. In his report, published in 1904, on the Province of Szechwan, His Majesty's then Consul-General for that province, Mr. (now Sir Alexander) Hosie, gave a list of 189 vegetable and 31 animal medicines made and used by the Chinese of Szechwan from time immemorial. He states that liquorice and rhubarb are the chief Szechwan drugs that interest foreigners. It is not to be concluded that the 220 drugs listed by Mr. Hosie (which list by no means exhausts the materia medica of Szechwan) are all, or in large part, efficacious. The great materia medica compiled in the sixteenth century is composed of fifty-two volumes, and contains 1,892 remedies. Among the drugs most used are ginseng, rhubarb, liquorice, pomegranate root, aconite, opium, arsenic, and mercury. Various superstitions exist in China, and until science comes to the aid of the people one need expect no really intelligent discrimination in the use of the many medicines in which the country abounds. Yünnan is rich in herbs and medicines. Manufacturers of drugs should find in China some valuable sources of supply of raw materials.

China exports annually more than 3,000,000 taels worth of medicines. The internal trade in medicines is enormous. Foreign exploiters of proprietary medicines have found China a rich field for their products, when extensively and attractively advertised. The Japanese nostrum "Jen Tan," translated "benevolent pill," which is being sold to the people all over China in increasingly large quantities through a most energetic and enterprising advertising campaign, uses the slogan "From death to life"—in Chinese characters, of course.

Paper.—China invented paper, but the processes of manufacture still remain crude. Rice straw is most commonly used, but only for coarse papers. Bamboo, treated with chloride of lime and soda to reduce it to a pulp, forms the material second in importance in the manufacture of paper in China. Fukien Province produces the largest quantity of paper, and Kiangsi Province ranks second, with Szechwan third.

Pottery and Porcelain.—Pottery and porcelain seem to have had their inception in China; at least, the Chinese claim the invention of the potter's wheel. China's exports of chinaware and porcelain amount to about 1,300,000 taels a year, the greater part being shipped from Kiukiang, which is the port for the Kingtehchen porcelain district. The porcelain industry at Kingtehchen, in Kiangsi, was established during the Han Dynasty as the Imperial pottery. It is now making cheap porcelains, and recently began the imitation of foreign patterns with some success. It is stated that the potters intend to imitate some of the old patterns made during the Tang Dynasty. There are more than 100 furnaces at Kingtehchen, employing about 150,000 men. The exports of pottery and earthenwares amount to about 1,000,000 taels per annum. Shanghai, Swatow, and Canton are the principal ports from which these goods are exported.

Rugs.—The war lifted the Chinese rug industry

with its centuries of indifferent activity, from a position of obscurity in relation to the West to a place of popularity and permanency in Western markets, principally because the supply of Oriental rugs from Persia and Turkey was cut off from the American market at a time when large accumulations of wealth had increased the demand. During the past few years Shanghai has been developing the rug industry, and hopes are entertained that with better organisation, and with the use of machinery, a standardised high-grade rug can be produced.

Straw Braid.—The war has played havoc with the straw braid industry of Shantung, which prior thereto had assumed a position of considerable importance in the trade of the province, although the exports varied considerably from year to year on account of changes in the style of hats for which the straw braid was used, and variations in the supplies of wheat straw, affected by crop conditions. This industry developed around the little town of Shaho, in north-western Shantung, where the large peasant population became very adept at preparing the braid for the market. Men, women and children throughout that section of the province, after the wheat harvest and while awaiting the ripening of the autumn crops, engaged, almost in a body, in the stripping, cutting, sorting, bleaching, plaiting, joining together, and bundling of the product, ready for the small buyers who go about collecting the supplies to offer to the market. It was eventually sold to foreign merchants at Tsingtau, which had succeeded Chefoo as the port of export, and then shipped to the United Kingdom, where it was re-bleached and distributed to the markets in Europe and America which used this braid for straw hat manufacture. The exports averaged about 7,000,000 taels a year from 1910 to 1914. They had fallen in 1917 to 2,400,000 taels, because of the great difficulties in getting permits and space to export the product to England, the high silver exchange, and the disturbed conditions in Shantung, which drove the trade almost entirely away from the port of Tsingtau. The American market during 1917 imported *viâ* Tientsin the bulk of the Shantung straw braid, which was bleached in the United States, some of it being shipped to South America. It is expected that the straw braid trade will revive now that the war is over.

THE RHÔNE-RHINE WATERWAY.

Some interesting particulars are given in the "*Times*" *Trade Supplement* of the plans which are now being considered by the French Government for utilising the enormous power of the Rhône. The plans may be divided under three main headings. In the first place it is intended to convert the Rhône into a waterway navigable by 1,200-ton barges. This will link up Marseilles with the Lake of Geneva and the Rhine through Lyons, and will also give Marseilles inland water communication with the northern and western coasts of France.

In the second place it is estimated that the Rhône is capable of producing annually electricity equivalent in power to that furnished by 5,000,000 tons of coal. This energy is to be furnished by nineteen generating stations along the river between Marseilles and the Swiss frontier, with a total horse-power of nearly three-quarters of a million. A large amount of this power will be absorbed by Lyons and Marseilles, the two principal manufacturing towns of France. The Paris-Lyons-Mediterranean Railway will probably electrify a part at least of its system, and the proposals contained in the scheme also safeguard the claims of Paris and the Departments of the Seine and Seine-et-Oise upon the new source of national energy to be opened up.

The third heading is irrigation. The Rhône valley is exceedingly fertile, but in its lower regions irrigation is necessary for all crops except the vine.

It will, no doubt, be many years before the full programme can be carried out. All that the Bill, which is now before the French Parliament, attempts to do is to sanction the general ideas, without going into details. It fixes the general limit of expense and the proportion of the State's contribution. It determines the special rights of riverain regions over the power produced, and approves of an agreement being come to between the Swiss and French Governments, both for the exploitation and the construction of the new water-link between the two countries.

The total cost of the scheme is estimated at 2,500,000,000 francs. In the event of the State not being able to find within three years one contracting group able to carry out the whole work, it will be permitted to grant smaller concessions, each of which will carry control, under State guidance, of one of the six sections into which the Rhône system has been divided. These sections terminate at the following points: the sea, the junctions of the Gardon and the Isère, of the Saone and the Saviere Canal, and the Swiss border, the region of Lyons forming a section by itself. Two great barrages will have to be built; large sections of the river will have be "turned," by the construction of canals, and seventeen locks, each capable of accommodating 1,200-ton barges, must be made. In addition to this, nineteen power-stations will have to be provided, and irrigation arranged for 642,000 acres.

OBITUARY.

SIR JOHN JACKSON, C.V.O.—Sir John Jackson died suddenly on the 14th inst., whilst on a visit to Godalming.

He was born at York in 1851. At an early age he entered workshops at Newcastle, and subsequently studied engineering at the University of

Edinburgh. He secured his first contract at the age of twenty-five, and in the following year he carried through the difficult task of building in quicksands the Stobcross Docks at Glasgow. His next works were docks at Middlesbrough, Hartlepool, and North Sunderland, and then came his first contract with the War Office—the extension of the Admiralty Pier at Dover. He also constructed the commercial harbour there.

The last eight miles of the Manchester Ship Canal he carried out in two-thirds of the contract time, and on the completion of this he received his knighthood. Other important works of his were the laying of the foundations of the Tower Bridge, the docks at Swansea, Burntisland and Methil in Fifeshire, the deep lock at Barry, and the extension of the Admiralty works at Keyham. The last-named work took ten years to complete, and cost nearly £4,000,000.

In addition to his numerous works in this country, Sir John carried out many contracts in the overseas dominions and abroad. The chief of these were the new naval harbour and graving dock at Simon's Town, Cape Colony, the improvement of Singapore Harbour, the new breakwater at Victoria, British Columbia, and the arsenal at Ferrol. He built for the Chilian Government the line from Arica to La Paz in Bolivia, which crosses the Andes at a height of 14,500 feet, and he carried out the great irrigation works designed by Sir William Willcocks for Mesopotamia.

Sir John Jackson was elected Unionist M.P. for Devonport in 1910, and continued to act as one of the representatives of the borough till 1918, when he retired. He had been a member of the Royal Society of Arts since 1889.

GENERAL NOTES.

THE WORLD'S SUPPLIES OF WHEAT.—The important question of the future of wheat production, with special reference to the Empire, is dealt with at length in the current number of the *Bulletin* of the Imperial Institute. The annual production of wheat in the world prior to the war amounted to about 110,000,000 tons, the largest producers being the Russian Empire, with an output of 22,000,000 tons, and the United States, which provided nearly 19,000,000 tons. During the war the production in Europe as a whole, and in Russia in particular, decreased considerably, but outside Europe there was a great expansion. The acreage under wheat in Canada, the United States, Argentina, India, and Australia in 1918 was over 25 per cent. larger than the average acreage for the five years before the war, and it is considered that, at the present time, there is a sufficiency of wheat, even without the help of Russia, to meet the requirements of the world. As regards the future also there is reason for optimism. There are vast areas of land suitable for wheat-growing yet to be opened up in Canada, Australia, South America, Siberia, and other countries, whilst the present low average yield of 13 bushels per acre is susceptible of great improvement. In recent years the increase in the world's production has been due, to a great extent, to an increased yield per acre, and there is every reason to believe that with the introduction of improved drought- and rust-resistant varieties, the rise will be even more rapid in the future.

UTILISATION OF SLATE WASTE.—A new use for the vast quantities of waste material produced in quarrying slate has, according to the *Chemical Trade Journal*, been developed in Carnarvonshire, where a company is powdering the waste and selling it as a filling material. It is said to be useful in the manufacture of asphalt, bricks, cement, abrasive soaps, cleansers, glass, linoleum, moulded and mechanical rubber goods, pottery, slabs and tiles, distempers, paints, insulators, etc. It produces bricks which are at the same time dense, strong, and hard, and which show a considerable saving in manufacturing costs. The silica content ensures that they are capable of withstanding a very high temperature.

COLONIAL AGRICULTURAL DEPARTMENTS. — A committee has been appointed by the Secretary of State for the Colonies to consider whether the staffs of the above departments are adequate and sufficiently remunerated, and to make recommendations for improving the arrangements for recruiting those staffs. The chairman is Sir Herbert Read, and the other members of the committee are Sir David Prain, Sir Henry Birchenough (Empire Cotton-Growing Committee), Professor J. B. Farmer, Sir Francis Watts, and Major R. D. Furse.

GERMANY AND OVERSEAS MARKETS.—In spite of the difficulties confronting Germany in the resumption of world trade, German traders, says the *Board of Trade Journal*, are showing great activity in their efforts to resume pre-war connections in all parts of the world. Certain Germans in Brazil have recently forwarded samples of certain local products to Rotterdam for Germany. The samples comprised 43 packages of a net weight of 3,269 kilos. The above is interesting as it shows that by forwarding samples the Germans, with their usual thoroughness, have again begun at the beginning. Consignments of German goods have also arrived at Bahia. One in particular, which was sent out through an intermediary, consisted of small ware of all descriptions. Again, a well-known German house at Solingen has placed its catalogues in circulation at Bahia, offering scissors at 8 to 51·60 marks per dozen plus 30 per cent. over 1914 prices. This quotation brings the price of the most expensive scissors manufactured by this firm to between 5 to 6 marks per pair. The largest and best quality of scissors would cost 1·4 milreis or five to six times less than the same size or quality coming from the United Kingdom or the United States of America.

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FRIDAY, DECEMBER 26, 1919.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

FRIDAY, JANUARY 2nd, at 4.30 p.m. (Indian Section.) A. P. MORRIS, B.Sc., A.M.Inst.C.E., Provincial Art Officer, Burma, "Burmese Village Industries: their Present State and Possible Development." SIR HARVEY ADAMSON, K.C.S.I., M.A., LL.D., Lieutenant-Governor of Burma, 1910-15, will preside.

JUVENILE LECTURES.

The usual short course of lectures adapted to a juvenile audience will be delivered on Wednesday afternoons, January 7th and 14th, 1920, at 3 p.m., by MR. LOUGHNAN PENDRED, M.I.Mech.E., Editor of *The Engineer*, on "Railways and Engines." The lectures will be fully illustrated with working models and lantern-slides.

Special tickets are required for these lectures, and no person can be admitted without one. A few tickets are still left, and these will be issued to Fellows who apply for them at once.

REPRINT OF CANTOR LECTURES.

The Cantor Lectures on "Coal and its Conservation," by WILLIAM ARTHUR BONE, D.Sc., Ph.D., F.R.S., Professor of Chemical Technology at the Imperial College of Science and Technology, have been reprinted from the *Journal*, and the pamphlet (price 1*s.* 6*d.*) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C. (2)

A full list of the lectures which have been published separately, and are still on sale, can also be obtained on application.

BOOKS OF TICKETS.

Every Fellow is entitled to admit two friends to the Meetings of the Society (with the exception of the Juvenile Lectures, for which special tickets are necessary). Books of tickets for this purpose can be obtained on application to the Secretary.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and copies can be obtained on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, December 9th, 1919; Lieut.-Colonel L. S. Amery, M.P., Under-Secretary of State for the Colonies, in the chair.

The paper read was—

PROBLEMS OF THE WEST INDIES.

By SIR EDWARD DAVSON.

The world convulsion, of which the aftermath is now being reaped, has left the nations face to face with new problems of every kind—social, political, financial, and commercial. To this country one of the most important is the problem of the Empire, what its future is to be, how far the political ambitions of our Dominions and Colonies can be satisfied, to what extent Imperial unity and solidarity can be hastened and achieved, and how we can best develop those resources which have in the past been partly neglected, but which it is now both a duty and a necessity to develop to the utmost of our power.

This problem is occupying men's thoughts, not only at home but throughout our Overseas possessions, and our West Indian Colonies are no exception. In accordance with the title of this paper I shall this afternoon confine myself to them, and venture to set before you their aims and aspirations, and also the steps that, as I think, should be taken to realise them.

Let me in the first place remind you of the geography of the West Indies; how, starting from British Honduras in Central America, we pass east to Jamaica, and thence farther east to the Virgin Islands; how, like the arc of a bow, the islands then run south to British Guiana in South America, thus almost encircling the Caribbean Sea. They have an area of 111,000 square miles, a population of 2,100,000, and a trade of £30,000,000.

Let me also remind you that they are our oldest group of Colonies, and in the early days were a source of wealth to Great Britain. Then came the lean years when they suffered greatly, and when they felt that they were neglected and almost forgotten; and then the war, when, realising how much was at stake, they, like other parts of the Empire, gave all they could of men and money for the cause. As elsewhere, the war brought its sorrows and the end its burdens; but, nevertheless, in one sense it has brought advantage, for as the world-wide need of foodstuffs has arisen, so have the products of the West Indies been in demand, and these Colonies have consequently reached a state of prosperity which they have not enjoyed for more than a hundred years.

I do not know if it is this prosperity which has drawn the attention of the United States, or if it is rather a development of what may seem to them a natural and laudable desire to make their sphere of influence in Caribbean waters single and complete; but the fact remains that the acquisition of the British, and also French, West Indies, as a development of the Monroe doctrine, has recently received much attention in America.

The argument in favour of this has been somewhat ingeniously put by Professor Shepherd, of Columbia University, in an address delivered to the Academy of Political Science at Long Beach, where he gives three reasons why, as he puts it, the Caribbean Sea should be made into an American lake—the first being that they, the States, need these areas themselves; the second, that the European owners do not; and the third, a natural consequence of the two preceding, namely, that the owners ought to turn them over to the States for the good of all concerned. The argument for our handing them over is also stated as follows:—

"If Great Britain and France are to derive material compensation from a victory rendered certain by the opportune aid of the United States, it is only fair and just that they should turn over their Caribbean possessions to this country as a fitting token of gratitude for our support."

I do not think that there is any need to take up your time in discussing this proposal, nor need I do more than refer to the singular suggestion recently propounded by Lord Rothermere and others, that we should sell the West Indies to the United States, in order to obtain money to improve our financial position. The suggestion has raised a storm of indignation in the West Indies, which has only been appeased by Lord Milner's recent emphatic declaration that we had no intention of parting with the West Indies. I can only add that the suggestion shows a strange ignorance of the theory and spirit of Empire, which is based on something deeper than Treasury balances and rates of exchange. We shall restore our financial position by increasing our production, and the West Indies mean in the future to play a not unimportant part in bringing this about. Self-determination is a phrase of the moment, and people on both sides of the Atlantic can rest assured that the West Indian Colonies have every determination to remain under the British flag.

These matters, on which I have perhaps dwelt unduly, lead me to the consideration of a further suggestion that has been made as to the future of the West Indies. The Dominion of Canada claims that if the West Indies are to be taken care of by any Western Power, they should more fitly be absorbed into the Dominion. Canada, so it is argued, needs tropical territories and outlets for her exports to such lands even more than the United States, which already has certain possessions and spheres of influence in those parts, while she could hasten their development to a greater extent than can England, with its many obligations in other directions. This is a proposition that obviously calls for greater consideration than the other, although the West Indies have never lost their belief that England itself would one day—and we hope that the time has now arrived—realise their potentialities, and do its best to develop their resources.

Let me say at once that there is no existing desire in the West Indies to have political federation with Canada; but even if there were there is one, to my mind, insuperable difficulty in the fact that Canada, in absorbing two millions mostly of coloured people in their own population of eight millions, would be giving West Indians a great share of political power in Canadian affairs. The only alternative

would be to treat the West Indies as dependencies under some form of Canadian Colonial Office Government; but this does not appeal to West Indians, who feel that it is better to bear the rulers they have than fly to others that they know not of.

Do not think that this means any lack of good feeling towards the Dominion; on the contrary, the West Indies fully appreciate all that she has done for them in the past, and look forward to a constant increase in the future in the trading relations which have been happily established by the Canadian West Indian Reciprocity Agreement in 1913. My own feeling is that it is better to let these relations grow and ripen, rather than try to force any development such as that which I have indicated.

But it is said—and I think that this is the root cause of both these proposals—that in these days of combination and concentration, it is economically impossible to regard as a permanence a scattered group of colonies lacking in political cohesion and commercial unity, each pursuing its own little path, and being overlooked and over-ruled when it comes in contact with the outside world, and in this I am inclined to agree. The history of Imperial development emphasises this view, for we see how different groups of colonies—in Canada, in Australia, and South Africa—some of them starting as Crown Colonies, have gradually drawn closer together until they have become federated into a Dominion, a Commonwealth, or a Union. Both then for their own advancement and protection, I think that the West Indies must aim at becoming in some form federated, and when that is accomplished, then will be the time to consider whether they would derive advantage by a further federation with another part of the Empire.

The problem of West Indian federation is, however, a difficult one, for their geographical position in relation to each other as islands creates obstacles which do not exist in considering the federation of contiguous colonies on the mainland; while the different forms of Government in the West Indies, ranging from the full representative Government of Barbados to the purely Crown Colony Government of the lesser islands, do not facilitate a solution of the problem. In the history of the West Indies, attempts have been made to combine or federate various parts, but these have always proved unsuccessful, except in the case of the Leeward Islands Federacy, which still exists, and which is the only Crown Colony federation in the Empire.

It does not follow, however, that because attempts have failed in the past they should necessarily fail in these days of more enlightened views and broader vision. Various schemes have been put forward, notably one by Mr. Gideon Murray, late Administrator of St. Lucia. which aims at creating a central Federal Council out of the various forms of local government, and which has aroused much interest in West Indian circles. Another proposal has been to extend the Leeward Island Federacy to Trinidad and the Windward Islands, thus creating in the first place a federation of the West Indian Crown Colonies, and leaving Barbados and British Guiana with their more representative Government, and Jamaica, the Bahamas and British Honduras for further and later consideration in this respect.

There are, however, two essential points to be borne in mind. The first is that there must be what I may call the "will to federate," and while it is undoubted that this is already beginning to grow, one finds at the same time the opinion largely held that federation, like the Canadian question, should not be forced, but should be allowed to grow and ripen as people increasingly appreciate the advantages of a constantly developing community of thought and action.

And the second point is, that if a people aspires to become a federation or commonwealth, if it aims at taking its place with other colonies in the councils of the Empire, it must not only develop its material life to the utmost of its capacity, but it must also educate itself, it must so raise its standard of thought and extend its vision that it can rightfully claim that its opinion may be treated with respect in considering the greater problems with which it would then be faced.

As regards the first point, the "will to federate," which in its elementary form simply means a growing appreciation of the benefits to be derived from a unity of thought and action—this, as I have said, is already in process of evolution. For some years past, conferences which representatives of most of the West Indian Colonies have attended, have from time to time been held to consider such matters of common interest as mail contracts, quarantine regulations, and the establishment of a West Indian Court of Appeal. The most recent conference was held this year to consider customs matters, and its very important findings are now being considered by the various Governments. Amongst other recommendations it has proposed the introduction of a

Model Customs Ordinance and a Customs Duties Ordinance, by which the laws and regulations, and also the classification of articles, should be identical in all the Colonies, instead of being, as now, so hopelessly diverse as to prevent any comparison between Colonies or any compilation of combined figures for the benefit of those who wish to study West Indian trade statistics.

Two very important resolutions were also passed, one being that a system of free tariffs in colonial products (other than rice and oil) should be established between British West Indian Colonies and British Guiana, which means that in future the products of any one Colony could be imported into any other Colony without payment of duty. The other was that the Colonies concerned should enter into a Customs Union, and adopt a uniform tariff under which the receipts should be pooled and allocated to each Colony in proportion to its dutiable imports. This establishment of free trade between the Colonies, and this right to move duty-paid imports from one Colony to another without payment of further duty, would be a great step forward. The Collector of Customs in Trinidad, in his report to the Government, says of this: "Its adoption would draw the Colonies closer together in trade and other questions, largely increase trade and communication, and secure for some of the smaller Colonies a reasonable tariff instead of the unsound and indefensible tariffs with which they are now burdened. It would also place the Colonies forming the Union, whose total trade is some £30,000,000 per annum, in a much stronger position to negotiate trade agreements, etc., than they are now."

Yet another resolution recommends the establishment of a Central West Indian Customs authority; and it will be obvious how much the resolutions, if carried out, would tend to bring these Colonies together in a bond of common material interest.

I have already mentioned the formation of a Judicial Court of Appeal, the enabling Act for which comes into force next July. This will be composed of the Chief Justices of the various Colonies, and will travel round the West Indies to hear appeal cases. It may tend to a reduction in the number of local judges, and it will ensure that the judge who tries a case does not also sit on the same case in appeal as frequently now happens. The formation of this Court has been facilitated by the abandonment of Roman-Dutch Law in favour of English Common Law in British Guiana, a step largely due to the initiative of Dr. Nunan, the Attorney-General of that Colony.

I would also like to mention the work of the Associated Chamber of Commerce, which held its first meeting in 1917, and of which the second meeting is to be held next February, when it is hoped that delegates from all the West Indian Colonies, and also representatives of affiliated associations in England and Canada, will be present. It is intended that all matters bearing on trade and commerce and cognate subjects will be fully discussed, and I need hardly point out the benefit which must be derived from men from the different Islands meeting together, learning each other's point of view, finding out where their various interests clash or agree, and then coming to decisions which are for the benefit of the whole rather than a part.

The Association is but in its infancy, and I look to see it, as it matures, greatly extend its work and influence I look to it, as it becomes financially stronger, to keep in close touch with all the Chambers, to be a kind of clearing-house for them all, collecting and disseminating trade news and statistics by its publications, and, in fact, to become what I may call the Central Council of a Commercial Federation.

I have mentioned the foregoing as illustrations of the growth of the will to federate, of the increasing tendency for each colony to work in harmony and union with the others. I have also spoken of the need of the West Indies to use—or perhaps I should say to continue—their efforts to raise their people, both physically and mentally, to as high a status as possible. As a means to this, I should place education first, for it is a truism, although perhaps not fully recognised in former days, that the better and more fittingly you educate people, the better citizens they become. I have used the words "more fittingly" because misdirected education may sometimes tempt people out of their environment, and may only cause the young generation to seek such walks in life as there is, except for the few, little opportunity to pursue. Compulsory education, greater opportunities for secondary education, an increase of technical schools and agricultural training, are all things to be aimed at, but before this there is the need of finding and adequately paying as teachers those who have the gift of teaching, and seeing to it that they themselves are taught what to teach and how to teach it.

In this connection an interesting memorandum has been put forward by Mr. Popham Lobb,

Administrator of St. Vincent, in which he refers to the underpayment and want of vocational training of teachers in the primary schools in the West Indies, although in some of the larger Colonies there may be less to complain of, and in Jamaica an Educational Conference has just made important recommendations on this subject.

Mr. Lobb remarks as follows :—

"Speaking subject to correction, I believe it is a fact that with few exceptions the teaching staff in the primary schools in the West Indies have themselves received no education either in subjects or methods other than that derived from the study of text-books in their spare time. Conditions are worse in this respect in the smaller Colonies; but it will hardly be contested that there is room for improvement in the vocational training of teachers, or that it would be followed by a marked improvement in the pupils' standard of knowledge. Such training cannot be satisfactorily provided except by a central institution, which would be well worth the cost for that purpose alone.

"Under present conditions, the teachers, so far as my experience goes, work as isolated units lacking the consciousness of belonging to one of the highest of all professions, and the stimulus that comes from a sense of common effort in a great cause. A sound training, received in common with teachers from other Colonies, would not only increase the value of their work, but do much to broaden their outlook and interests."

Mr. Lobb therefore suggests the institution of a Central College, which would provide a course of training for primary school teachers, to include thorough instruction in hygiene and sanitation.

The two last subjects are rightly included, because there is no doubt that the question of health conditions is one of the most important of those with which the West Indies has to grapple. I shall not burden you with statistics, but it may be accepted that while conditions and specific diseases vary in different colonies, yet the amount of disease and consequent reduction in human efficiency is very great. In the past such diseases have been considered as unavoidable concomitants of life in the Tropics, but medical research in recent years has shown that tropical diseases can be greatly reduced if not entirely eradicated by the adoption of hygienic and sanitary principles. We have already removed yellow fever, which was once the curse of the West Indies, and the Americans have shown us how malaria can be got rid of by their work in the Panama Canal zone. It may be hoped, therefore, that British Guiana, for instance, will be able, as funds permit, gradually to reduce malaria, which has so injuriously affected its population in the past; but as to the eradication of which, I am glad to say, the local Government is now quite alive. In addition, there are in the West Indies such diseases as filariasis, ankylostomiasis, leprosy, pellagra, tuberculosis and venereal diseases, which all take their toll, while infantile mortality stands at a much higher percentage figure than should be the case.

These points, I know, are being more and more realised; but lack of funds and the absence of specialised knowledge and central control are obvious hindrances to any appreciable amelioration. In this respect three things are required: First, that instruction in the principles of hygiene and sanitation should be given to children in schools, as it is obvious that it is easier to train children under supervision than adults who are not; while it is also borne in mind that such instruction cannot be given unless the teachers themselves have already been instructed. Secondly, the medical services of the West Indies should be put on a better footing, and salaries and possibly pensions should be sufficiently large to attract the best type of medical officer. I am glad to say that this matter is receiving the attention of the Colonial Office, and that Lord Milner has appointed a committee of inquiry to investigate the subject, and one may hope that this may even lead to the possibility of assimilating the medical services of neighbouring Colonies. The third point is that individual diseases should be attacked in turn by an organised scientific body, well equipped both financially and scientifically. The Rockefeller Institute furnishes an example of what I mean, for its services to the West Indies in fighting parasitic diseases have been of the utmost value. I feel, however, that the health improvement of our Colonies should not be dependent upon the generosity of an American institution, and I hope that the London School of Tropical Medicine, which I understand is about to enlarge its sphere of usefulness, may be able to undertake some of this important work. In this connection Dr. Louis Sambon, the eminent specialist in tropical diseases, has put forward an interesting proposal to transfer part of the tuition in tropical medicine to these Colonies, where not only the necessary material can be found, but the

surroundings and the sanitary measures at present existing can be studied. At the same time a complete medical survey of the whole group is suggested, with a view to establishing the distribution of the various diseases, their œcological factors, and the best methods of prevention.

Time prevents my dealing further with this mportant subject, but the idea of organising a specialised campaign against these diseases is one that must appeal to any one who realises how seriously they may retard the development of our Colonies.

I have referred to their serious effect upon the supply of efficient labour, and I would like to touch on another point in the labour problem, which is that one frequently hears the cry of a shortage of labour, and at the same time finds large numbers of labourers emigrating to foreign lands. It is well known that in past years the West Indies have been looked upon as a source of labour supply for developing neighbouring foreign countries, as witness the construction of the Panama Canal, the Madeira-Marmore Railway in Brazil, the development of bananas in Costa Rica, and of sugar in St. Domingo and Cuba; and even now recruiting is being carried on in Barbados and Jamaica for the last-named place. It has sometimes been said that the West Indian labourer is indolent; but, apart from the effect of diseases, this statement cannot be maintained, as his services are so much in demand in those countries to which I have referred, where he has the reputation of being a hard and conscientious worker. It may be that he works best when away from his home environment; but if so, surely the right course is to encourage him, should he show himself dissatisfied with the conditions of his own island, to migrate, not—as now—to a foreign country, where he is removed to a large extent from the protection of the flag, but to one of the other Colonies where his services are in greater demand. One would instance in this connection the Colony of British Guiana, whose resources are at present scarcely touched owing to the absence of a labour supply, and where—all things considered—wages as good as elsewhere can be earned. Wherever employers can offer satisfactory conditions of life, suitable dwellings, comfortable transport and an adequate wage—which they have not always been able to do in the past—I am sure that they can compete with foreign recruiters. I look forward then to seeing Labour Exchanges established among the different Colonies where the attractions of such employment, the terms of contracts, and the conditions of life can be put before intending emigrants.

In dealing with prospective developments, I must not omit to mention the proposal, advocated by Sir Francis Watts, Imperial Commissioner of Agriculture, for the formation of a College of Tropical Agriculture. This matter has recently been considered by a Committee appointed by the Secretary of State for the Colonies. The report is not yet published, but it is to be hoped that it will favour the establishment of such a college in one of the islands, where not only may West Indians, who are anxious for education in agricultural science, receive training, but where more advanced pupils, such as post-graduates from universities, may be able to study the higher branches of agricultural science. Such a college would be of more than local benefit, as it would give an opportunity for study which is so far unobtainable for those who desire to receive such training throughout the Empire.

Nor must I omit to refer to the excellent work of the Department of Agriculture itself, and to express the hope that this work may not only be continued, but may be put on such a financial footing as to enable it to increase its activities and usefulness. Nor yet again must I omit to mention the really useful work which is being done by the West India Committee in ventilating West Indian affairs in this country, and in generally helping to enhance the welfare of these Colonies.

Finally, I should like to say a few words about trade and commerce, for even as these higher aims which I have endeavoured to indicate depend upon the means to carry them out, so do the means depend—so far as the West Indies are concerned—not only upon the production of wealth, but also upon the securing of profitable markets for their products, and of efficient means of transport to and communication with those markets.

As regards trade, the West Indies have for many years claimed that their future development and prosperity depended largely on their preferential treatment in the home markets, and that they, as loyal Colonies, had the right to look for more favourable treatment from the Motherland than the stranger whose interests could never be identical. Their hope has now been realised by the preference granted this year, which is therefore not only of material benefit, but which—and this is equally important—has shown that the home country accepts their view, whereby they are correspondingly heartened and encouraged. It is probable that

the West Indies may reciprocate by increasing their preference to 50 per cent., and it is to be hoped that this increase will also be extended to Canada, and that Canada will reciprocate to a like extent. Thus, as I hope, we may see the initiation of an Imperial Preference of 50 per cent. which may gradually extend throughout the Empire. A further suggestion has been made that British Guiana should form a Customs Union with Canada, but I confess that I should like to see a West Indian Customs Union first, and that, to me at least, the difficulties seem to outweigh the advantages. Nevertheless, one must not dogmatise too early, and the question may be worth close and scientific investigation. But, apart from this, these preferential arrangements, both with Great Britain and Canada, if they can be made enduring, should solve the problem of finding markets for West Indian products.

As regards transport, *i.e.* steamship services, the West Indies have little reason either now or during the war to complain of cargo tonnage, as they are well provided for in this respect, not only for their trade with England, but also with Canada and the United States. The question of a passenger and mail service to this country is, however, a more difficult one, and concerning this a committee appointed by the Colonial Office has just presented a report. Figures show that a high-class service of this kind, such as is desired, cannot be self-supporting, and it is clear that at the present time the cost of building would make the amount of subsidies required too heavy a burden. The cost will presumably decrease in time, but the solution may possibly be found in the provision of more modest passenger and cargo vessels, which may provide at least adequate passenger accommodation while enabling the ships partly to pay their way through their freight-earning capacity. Should it prove feasible to combine the present Canadian-West Indian subsidised line with an English-West Indian line, by running through steamers to Canada from England *viâ* the West Indies and *vice versâ*, it is probable that certain economies might be effected.

The other point is that of cable communication. In days of modern commerce, the cable is to the business firm what the voice is to the individual, and, if this be accepted, then one must confess that recently West Indian firms have been almost inarticulate. Frequently broken cables, alleviated sometimes by spasmodic efforts at wireless, but more frequently only by sending messages by ships, have resulted in incredible delays, and sometimes in the total disappearance of messages *en route*. Except in the case of Jamaica, the only existing cable runs through divers foreign lands, and the request of the West Indies that they might have a new all-red cable service has so far fallen on unheeding ears. This is the more strange, as the subsidies at present being paid by England, Canada, and the West Indies are more than sufficient to provide both interest and sinking fund on the required outlay. One may hope, therefore, that the Government, who to my mind should be the actual owners of all such strategic cables, may have such a scheme carried out by the time that the existing contract expires. In this connection I should also like to refer to the press of the West Indies. This is a valuable asset to them, and some of their papers can compare favourably with those of the Dominions and other Colonies. But the potency for good of the press must largely depend on its supply of news, and this alone would justify the call for a better cable service; nor can one hope to break down insular prejudice and mutual lack of knowledge, unless one has the lowest possible press rates between the different islands.

And now I have finished. I have not given you any description of the West Indies or their industries, and I have touched only lightly on their existing conditions of life. I have endeavoured rather to deal with those problems which lie before them, in the satisfactory solution of which, rather than in the attempted fomenting of sectional or racial prejudice—which one sometimes notices with regret—lies the best prospect for the abiding welfare and happiness of all concerned. And further, out of that growth of common interest, and of the increasing realisation of the benefit of co-operative progress which I have ventured to indicate, out of that, as I believe, will arise a new West Indies, strengthened, united, and more powerful, which will in due time be able to take a place in the Imperial scheme worthy of the Colonies which a hundred years ago were called the brightest Jewels of the Crown.

DISCUSSION.

The Chairman (Lieut.-Colonel L. S. Amery, M.P., Under-Secretary of State for the Colonies), in opening the discussion, said he thought they could all congratulate themselves on having come to hear Sir Edward Davson's paper. At the very outset Sir Edward had given the discussion of West Indian problems its proper framework and background by treating them as part of the whole great problem of Empire, of Imperial unity and

development, by the solving of which they would be able to solve the problems which affected them locally. He was convinced that the problems which faced England and each separate portion of the Empire in the years to come could never be successfully dealt with if they were tackled in a purely local spirit; they could only be solved as part of the whole problem of Imperial development. To obtain the fullest economic development and national life of each part of the Empire required the co-operation of, and the maintenance of effective unity with, the rest of the Empire. From the economic point of view above all, the hope of bringing back prosperity to this country, and of achieving a higher level of prosperity than had ever been enjoyed in the past, in spite of the immense burden of debt which lay upon us, could only lie in the development of the Empire. He agreed most whole-heartedly with Sir Edward Davson's view that to restore our financial position we must look to the keeping and developing of the Empire, and not to getting rid of it. For his part, he attached no importance whatever to the ill-informed suggestions which had been put forward, or which might be put forward in the future, to the effect that the British Empire should thrust out, as part of a cash transaction, any essential part of that Empire, and above all those Colonies which had played so great a part in British history in the past, and which he believed would play as great a part in the future. Sir Edward had also touched upon the possibility of political union of the West Indies with Canada. That, of course, was on an entirely different plane from the other suggestion; there was no question of the Flag involved. It was merely a question of practical administrative considerations, some of which Sir Edward had drawn attention to. Whatever the difficulties in the way of such a union might be, he believed that closer relations, both of trade and personal intercourse, between the West Indies and Canada, as well as between the West Indies and the United Kingdom, would be of advantage to all three countries. He did not think that all the development in the Empire should be done by the United Kingdom as the centre, regarding the other parts as mere dependencies and satellites. He regarded Imperial preference as a means by which each part of the Empire should take the closest interest in the development of every other part, and by its trade mutually help the development of every other part. England had established, and he believed for good and all, the principle of Imperial preference. That principle was of value, not only in the material assistance which it gave to some parts of the Empire, and more particularly to the West Indies, but also as the assertion of a very definite new conception of Imperial development. That conception was not one of exclusion or monopoly. By Imperial preference they did not mean that they should stop trading with the outside world. But they did feel that the advantages secured by each part of the Empire helping every other part were so great that wherever possible they should try to put inter-Imperial trade first, and he had not the slightest doubt that the development of that principle, not only in the matter of customs duties, but in every other sphere, would mean an immense development within the Empire. It only meant the conservation of economic energy within their frontiers. He had been very pleased to note the emphasis Sir Edward Davson laid on the problem of education. If economic development was required, a beginning must be made by developing the individuals who were going to do the work. He was also glad to see the way in which Sir Edward linked up health with education. In the West Indies, and many other tropical regions, the alphabet of education ought to be education in hygiene. Children should be taught the elementary principles of sanitation and hygiene before they were taught their letters. Equally essential, at the other end of the scale, was higher education, the higher work of research, and the training of the few teachers and experts whose work could be of such enormous value to the people for whom they laboured. He was glad Sir Edward had paid a tribute to the remarkable work achieved by the Imperial Department of Agriculture, which owed its initiation and encouragement to the late Mr. Joseph Chamberlain. He thought that that work, which had already been of great value to the Empire, would receive a further impetus by the creation of a College of Tropical Agriculture in the West Indies, which would be the centre for study and research for the whole tropical world.

Sir Sydney Olivier, K.C.M.G., C.B., said he would first like to congratulate the Chairman on the announcement which had appeared in the papers that morning, that he would assume the full duties of the Secretary of State for the Colonies during Lord Milner's absence. Next, as a man who had all his life been interested in the West Indies, and who had studied their problems both in the Colonial Office and on the spot, he would like to join the Chairman in his congratulations to Sir Edward Davson on his exceedingly able paper. Dealing with Imperial preference, he thought that the preference accorded to the West Indies was only the discharge of an obligation which had been long overdue, but at the same time he thought it would be a mistake to encourage the West Indian Colonies to rely upon, or to think that they could not succeed without, the help of a 50 per cent. Imperial preference. It seemed a little injudicious to hold out that hope. Even the present preference, although of great benefit, was not sufficient to ensure the stability of, say, the West Indian sugar industry, unless the methods of production were considerably improved, because the competition of such a country as Cuba was so great—there were factories in Cuba turning out from 50,000 tons to 100,000

tons a year with very cheap cultivation on virgin soils—that she had an advantage over the West Indies which was very much more than the preference which had been given to the latter. With reference to the question of labour, Sir Edward Davson said he thought that the British West Indies might be able to offer conditions of employment as good as those given by Cuba and other countries. That was a rather sanguine view. Cuban factories were offering 3½ dollars a day to the men who cut their cane harvest. That caused a severe draft on West Indian labour supply; no one in British Guiana could offer as much. But, as Sir Edward had said, if West Indian planters would take advantage of the high prices now obtaining for their products—especially sugar —and lay down improved factories and offer their workmen a larger share in the prosperity of their undertakings, he thought they would be able, if not to attract immigrants, at any rate to retain their own labourers. With regard to the political future of the West Indies, he wished to make a complaint which all who were interested in them would endorse. Whenever people in Great Britain, though with the best possible intentions, turned their attention to the West Indies, they began by offering them large schemes of political reorganisation, such as annexation to the United States or federation amongst themselves. They always offered wide generalities of that sort, which made no appeal to any West Indian. People in Great Britain and elsewhere did not understand the status of the West Indies in the eyes of their inhabitants. To take Jamaica as an example, Jamaica had an area as large as Kent, Surrey, Sussex and Middlesex put together, with a community nearly as large as the population of New Zealand, which had been developing for over 250 years, and which had a deeply-founded National life of its own. A Jamaican thought of himself as a Jamaican, and as a member of the British Empire, and people who talked lightly about annexing him to the United States or to Canada entirely ignored those sentiments. The question of Federation put forward by Sir Edward was one that they could not ignore. On account of the great distances between the different islands, almost all functions of government must be local functions; a centralised West Indian Government would have very little to do. The chief functions of government in the West Indies —police, education, public health, agriculture, roads, and so on—were local functions, which even in England were undertaken by local bodies. The feeling in the islands was that there would be very little for the Executive of such a central government to do, but at the same time it would be difficult for the Governors or officials of the various islands to spare the time to attend to or take part in a central government—they were on full-time jobs already. He thought that if a High Commissioner, together with a Council, was appointed, he should spend his time visiting the different islands and studying their problems, and not undertake the governing of them, at any rate to start with. With reference to the training of teachers, there were very good colleges for that purpose at Jamaica, Trinidad and Barbados. If West Indian institutions were to be centralised, they must not all be centralised at the same place. If something was done to establish a college for training students in tropical diseases, Jamaica would probably be the best place to establish it; Jamaica could produce samples of all West Indian diseases. He looked forward to the possibility of establishing a Central Agricultural College for the West Indies, as well as a Central Training College and a Central Medical College.

The Hon. Gideon Murray, M.P., late Administrator of St. Lucia, said he had the greatest admiration for the work Sir Edward Davson had done for the West Indies during the past ten years; the paper which Sir Edward had read represented to a large extent the same views as he himself held on the present position and future development of the West Indies. Dealing with the question of federation, he thought Sir Sydney Olivier had somewhat minimised the importance of those central objects which any form of federated government might have to deal with. It was quite true to say that the majority of West Indian issues and problems must be dealt with locally in the different Colonies, but there were quite a number of important matters which could, and should, in his opinion, be relegated to some central council, which could co-ordinate them from the point of view of all the Colonies concerned; matters like steamship services, cable communication, quarantine—questions of that sort, which during his stay in the West Indies had never received the assimilated consideration which they ought to have received, owing to the fact that they were settled locally. The fact that there were not a great number of such subjects was really an argument in favour of a central government. Sir Sydney Olivier had said that the officials and business people of the various islands had not the time to attend to a central government; but if there were not many subjects to be dealt with it would only be necessary for a Federal Council to sit perhaps once a year for a fortnight or three weeks in order to consider those matters. That was the view he had come to after a residence of eight or nine years in the West Indies; and since he had left a further issue had arisen which made it even more important, in his opinion, that a Federal Council should be instituted. Sir Edward Davson had referred to the desire which had been expressed by certain people in America to take over the West Indian Islands—a desire which, he was glad to see, had been utterly and entirely squashed by the pronouncements of Lord Milner and Colonel Amery on the subject. A desire had also been expressed by a number of Canadians to form a political

union with the West Indies. Arguments against both those courses had been adduced by Sir Edward Davson and Sir Sydney Olivier, and it was unnecessary for him to repeat them; but he would like to remind the meeting that all federations in the past had been formed owing to external causes and external pressure. The reason of the federation of the Australian States was the possibility of pressure from the North, and of the Canadian States the fear of pressure from the South; and the reason for the Union of South African States was the fear of the pressure which was beginning to exert itself from Germany. The West Indies at the present time had to face that pressure, although it was being applied in a friendly way. He hoped that when the question of closer union was considered, as he understood it would be by the West Indian Associated Chambers of Commerce at their next session in Barbados in February, they would not regard it purely from the point of view of internal considerations, but would take into account the external situation. He had listened with very great interest to Colonel Amery's remarks on the development of the Empire. In Great Britain there was an increasing tendency towards the nationalisation and socialisation of everything they possessed. That was a policy which would not suit the Colonies; and he believed the only way they could develop their Colonies to-day was by utilising that good old instrument of individual and private enterprise which had proved so successful in the past in the Dominions and Colonies. He had been sorry to observe that, in the West Indies, people seemed to depend far too much on Government assistance. They ought to put more initiative and more energy into the development of their own Colonies; but besides that he would like to see capital going to the West Indies from Great Britain and from Canada, because places like British Guiana and British Honduras were only awaiting the influx of labour and capital to become the richest prizes they possessed. He suggested that the policy of the Colonial Office should be to offer every inducement to the private individual who desired to develop and to place his capital in those splendid Colonies.

Major J. A. Burdon, C.M.G., Administrator of St. Kitts and Nevis, said that of all the problems on which Sir Edward Davson had touched, he considered that of health to be the most fascinating. They all knew the old ideal of making two ears of corn grow where one grew before—or of sending two cables where only one got through before—but the highest ideal was surely to get two babies to live where one had died before, and to rid the community of crippling and preventable diseases. In the islands in which he worked—St. Kitts and Nevis—the question of improving the health conditions was exceedingly pressing, in spite of the ideal climate which prevailed. The community and the Government were not greatly to blame; scientific ideas took a long time to penetrate to the outposts, and also required a good deal of money to carry out. The infant mortality in St. Kitts, due to the ignorance of the midwives and the lower classes generally, was appalling. They had commenced to combat that by starting a maternity ward and training school for midwives, of which he had great hopes. One of the most satisfactory things about improvements in sanitation was the fact that immediate results were obtained. In several instances places that were formerly plagued by mosquitoes had been entirely cleared of them by dealing with their breeding-grounds. There were many difficulties to be met with in extending the application of that method. The rocky watercourses, where every boulder formed a potential breeding-ground after rain, and the pits which were dug at intervals along the hill roads to prevent them being washed away, were difficult to deal with; the staff required to oil them would be larger than could be provided. He was confident, however, that those difficulties would eventually be overcome, and when that was done their malaria returns would be reduced. The doctors said that every third person in St. Kitts had got filaria, but when they abolished the mosquitoes the disease would die out. He was glad to be able to state from experience that any well-considered scheme for the improvement of health received most valuable support and sympathy from the Colonial Office. That, together with the fact that men like Sir Edward Davson and Mr. Moody Stuart were advocating and working for improved health conditions in the West Indies was a tremendous encouragement to those who, like himself, were working for the same end.

The Hon. C. Clementi, C.M.G., Colonial Secretary, British Guiana, said it had been his fate to spend the last six years of his life in British Guiana, and for almost one and a half years of that period he had administered the government of the Colony. Whereas in size British Guiana was four times as great as the whole of the remainder of the West Indies, its population was six-fold less. The Colony languished for lack of fundamental requirements. Without labour and capital nothing could be done to develop the Colony. Their primary need was a larger population, but during the past five years the death-rate had actually exceeded the birth-rate, so that the population was declining instead of increasing. So long as the population of Demerara continued to reside upon coastal flats, where drainage and irrigation problems were intensely difficult, where there was no good water-supply or method of disposing of sewage, and where mosquitoes bred in millions, sanitation would be very costly. The only alternative was to encourage settlement on the highland plateaux in the interior of the country. That part of the Colony was a "white man's land," as he could testify from experience, with beautiful scenery,

abundant supplies of pure water, and a soil of considerable fertility. At present, however, there were no means of communication with that region, and to provide access would be a very costly matter. Even if steps were taken to preserve the population now resident in British Guiana, and obtain from it a natural increment, that would not suffice for a country which was as large as England, Scotland and Wales, but had only the population of Hertfordshire, and in which the area in beneficial occupation was less than one-fifth of the area of Kent. Although Great Britain had been suffering from a shortage of sugar during the past few years, on the Corentyne coast of Berbice sugar had rotted in the fields for lack of labour to deal with it. In the sugar estates of Demerara, in March last, there were 83,000 acres of uncultivated land, whereas the cultivated area was only 73,000 acres; more than half the estates' acreage was lying fallow, in spite of the world-wide demand for sugar and the high price obtainable for it, owing to shortage of labour. They had attempted to import labour from the West Indian Islands, but except in the case of Barbados—which had a population of more than 1,000 to the square mile—none could be spared. But if the whole population of Barbados was transported to Demerara, the latter would only have a population of five to the square mile. They had to look to countries where the population was hundreds of millions, and naturally turned their thoughts towards India. Negotiations had been opened with the Government of India for that purpose; if they failed, he saw little hope for Demerara in the future, and even if they succeeded it would involve British Guiana in very heavy expenses for subsidising a line of steamships between India and Guiana, and for improving the harbour at Georgetown, because owing to the bar outside it was impossible for large steamers to enter. In addition, they would require a very large loan to improve their internal communications, and the only hope he saw of raising that was for a loan to be floated in London. During the last eighty-six years the white population had decreased from 3·6 per cent. to 1·1 per cent. of the total. Given labour and capital, sugar, rice, coffee, and limes could be grown on a very extensive scale, and in the interior there were herds of cattle that could be developed. The Colony was rich in timber, gold, diamonds, and bauxite. It had great resources of water-power. There was even hope that oil might be found in the north-west of the Colony. It was his sincere hope that through the Colonial Section of the Royal Society of Arts attention might be attracted to British Guiana.

Dr. Louis W. Sambon, M.D., said that in 1913 he had the opportunity of visiting the British West Indies on behalf of the Colonial Office, for the purpose of studying pellagra. In making some remarks on the health conditions of the West Indies, he did not wish to convey a wrong impression. Although several grave diseases were prevalent, the islands were not less healthy than some of the rural districts at home. However, sanitation had been sadly neglected and disease was rampant in many of the islands. The physicians there were zealous and well-informed, but they suffered from lack of laboratory equipment, means, support, and authority. Pellagra was a disease that had been recently discovered in the West Indies and had caused some alarm, especially in Jamaica and Barbados, simply because it had not been recognised before. That disease, which was very widely spread throughout the world, had been found by him in every one of the islands of the West Indies, although possibly in some of them it might not be locally contracted. He had studied especially Barbados, Antigua and Jamaica, and there he believed he was able to locate the exact sites where the disease was endemic. From the experience he had obtained during his visit to the West Indies he had formed some impressions which had led him to make a few suggestions. The first concerned the method of tuition in regard to tropical medicine. It was now over twenty years since the London School of Tropical Medicine was founded, and as he had been a teacher there since its foundation, he had a certain amount of experience. The technique of the laboratory was taught exceedingly well, and medical men were now prepared for their work in tropical Colonies far better than those who went out before the foundation of the School. They were shown specimens of all disease agents known, and were given an excellent idea of tropical diseases from the theoretical point of view, but the School lacked the clinical material that was so valuable in the education of medical men who intended to practise in tropical countries. Therefore he had suggested that, after a preliminary course at home, students should be sent to the Colonies in order to avail themselves of the necessary material, and probably no better place could be chosen for that purpose than the West Indies. In the West Indies most tropical diseases were represented, because those islands for centuries had received a constant stream of African and, more recently, Hindu and Chinese, labourers, and because they probably represented the remnant of a land, now submerged, which at one time united Africa, Brazil, India, and even Australia, which then formed one great continent. That was very long ago, perhaps before the tertiary period, but diseases were also very ancient. When people spoke of new diseases they generally meant diseases that had not been previously recognised. The very same parasites that now existed in Egypt could be actually found by making sections of mummies of people who lived there five thousand to seven thousand years ago, and parasites that now attacked mammals and birds could be traced in the present representatives of animals that lived long before mammals and birds came into existence. Those interesting facts might, perhaps, one day, lead people into a new field of research, namely, that of the tracing of diseases back along

the paths of their migration to their cradle lands. Thus, for instance, yellow fever was found on the west coast of Africa and also on the east coast of America, and why was it found on both sides of the Atlantic? It had probably been there from time immemorial, long before the discovery of the New World by Columbus, and had possibly been there from the time when the two continents were connected. With regard to the work that he thought should be carried out in the West Indies, one of his suggestions was that a complete and thorough medical survey should be made of the Lesser Antilles. They offered exceptional opportunities for the study of questions still unsolved in tropical medicine. Being small and very different in physical features, in geological structure, in flora, in fauna, and in diseases of men, animals and plants, they provided the best possible conditions for the investigation of the etiology, œcology, and epidemiology of diseases not yet elucidated. In one island certain factors were present that were absent in another. Therefore a number of factors that were non-essential could be at once eliminated and the actual causes of, or factors in, the occurrence of the diseases thus narrowed down could be easily determined. A medical survey of the kind he had indicated would lead to a considerable advance in the knowledge of tropical medicine, and already in visiting the various islands he was able to note peculiarities in the distribution of certain diseases such as blackwater fever, yaws and pellagra, which, when worked out, should lead to important discoveries. Further, he thought one of the islands—Barbados, for instance, that was already free from malaria yaws and other diseases, but still presented some important disease scourges such as pellagra, leprosy, ankylostomiasis and filariasis—might be chosen and an endeavour be made to rid the island of those diseases. The filariasis should disappear within a few months. He need not remind those present of what had been done in the Panama Canal zone and in the island of Cuba. In the Panama Canal zone yellow fever was got rid of in about eighteen months, and malaria also was reduced to almost complete disappearance. What had been done there could be done far more easily in the Lesser Antilles. Many years ago he suggested that the white man could live perfectly well in a tropical country. It was not the heat or other climatic conditions but the parasitism of the tropics that had brought about the wilting of the white race in tropical countries. At the time his remarks had not been taken seriously; but in 1914 Surgeon-General Gorgas came to London and told them that, only posted from infection, over 10,000 white men with their wives and children lived in Panama for over ten years, continually exposed to rain and heat and every possible condition of a tropical climate, in perfect health, and what had been done there could be accomplished anywhere else.

Lieut.-Colonel Sir James Hayes Sadler, K.C.M.G., C.B., in proposing a vote of thanks to Sir Edward Davson for his most able and valuable paper, regretted that, the hour being so late, he was unable to join in the discussion. He said that he had attended many lectures and heard many papers read, but it was rarely that he had heard one in which he took a greater interest than that read on the present occasion.

Mr. Byron Brenan, C.M.G., seconded the resolution, and in doing so said he was sure the author would be immensely gratified by the fact that every one of the speakers in the discussion began his remarks by announcing how very thoroughly he appreciated the value of the paper.

The motion was carried unanimously, and, the author having briefly replied, the meeting terminated.

COMMERCIAL POSSIBILITIES OF RIO HACHA DISTRICT, COLOMBIA.

Rio Hacha is situated near the Calancala River, on the boundary between the Province of Padilla, of which it is the capital, and the Goajira Peninsula. It is one of the oldest towns in Colombia, but little remains of the old Spanish buildings. There is no harbour, the sea being an open roadstead and very shallow, even small sailing vessels having to anchor at a distance of 1,000 yards from the beach; cargo is handled by means of small "cayucos" or large dug-out canoes. The lands in the interior are semi-arid, but subject to floods during excessive rainy seasons, the country being practically level, with little high ground.

From a report by the United States Trade Commissioner at Santa Marta on the commercial possibilities of the Rio Hacha district, it appears that there are extensive areas covered with a species of wild "magney," described as nature-sown plantations. The fibre is utilised by the Indians in making hammocks, and is of a finer quality than the "fique" of the interior. Samples have been submitted to Professor Dewey, fibre expert of the United States Department of Agriculture, who classifies this plant as *Furcraea macrophylla* and says that samples indicate that the fibre is finer, whiter, and softer than that either of the true sisal or the henequen of Yucatan. So far as is known, no fibre from these wild plants has been produced commercially. According to Professor Dawe, Agricultural Adviser to the Colombian Government, the possibilities of developing a new and important industry in this district appear to be very favourable.

The lands in the region of the Calancala River, excepting parts which are subject to overflow in the rainy season, are on the whole suitable for fibre cultivation. The situation of these lands is also favourable, being only four or five miles from the town of Rio Hacha. They are almost level or slightly undulating. The special recommendation lies in the fact that there is already a sufficient

supply for cutting, so that extraction could be begun as soon as machinery was installed. Cheap labour is obtainable, and the Calancala River would furnish ample water-power.

The aloe plant, which requires a dry soil, is found growing wild in the Goajira Peninsula. Near Rio Hacha there is a small aloe plantation, privately owned, which exported in 1915 about 500 lb. of extract, and in the first six months of 1916 over 1,000 lb. The leaves are ripe for the extraction of the drug in the dry season, when they assume a coloured hue.

The coast lands of the peninsula near Castilletes contain rich deposits of talc, which are being worked for export to Venezuela, its local value being about 16s. 8*d*. per ton. It is thought that more remunerative prices could be obtained in the United States, but lack of transportation has prohibited anything being done in this direction.

The Goajira Peninsula contains the principal supply of divi-divi in Colombia. The tree grows in the north-west part in the sandy lands along the coast.

The principal wealth of the north-western part of the peninsula lies in salt, salinas occurring along the coast practically throughout its whole extent. It is said that these salinas are capable of producing a million sacks annually. The present production is limited, owing to the fact that there are other salinas nearer to the centres of consumption, such as those near Barranquilla and at Santa Marta.

A new product found in the Rio Hacha district is known as "qüika" resin. This is produced by a small tree (*Cercidium spinosum*) (Tulsane) whose trunk and branches, and even roots when exposed to the air, are covered with a layer of resin. A single tree yields several pounds, and as the growth is very abundant in certain parts it should prove a valuable article for export. Samples have been sent to Europe and the United States for examination and report.

El Portete and Bahia Honda have been mentioned as new seaports for the Goajira Peninsula, with plans for a railway running south into the Valle de Upar district. Such a railway would tap the copper and coal deposits of the Villanueva region, as well as open the peninsula to agriculture and cattle-raising. This route is also attractive because it is the best one to Bogotá, the higher and more difficult ranges of the Andes being avoided.

MANUFACTURE OF ANGOSTURA BITTERS IN TRINIDAD.

One of the most important industries of Trinidad is the manufacture of Angostura bitters, the island having a monopoly of this speciality, which is exported to all parts of the world. In 1917 the United Kingdom, despite difficulties of sea carriage, took 10,534 gallons of bitters, and the United States 9,397 gallons, out of a total quantity exported of 22,667 gallons, valued at some £24,000.

According to a report by the United States Consul at Port of Spain, the inventor of Angostura bitters was Dr. Johann Siegert, who was born in Silesia in 1796. He went to Venezuela in 1820, finally settling in Angostura (now known as Ciudad Bolivar), on the Orinoco River, where he practised as a physician and devoted special attention to the study of tropical herbs and plants having medicinal value.

In 1824 Dr. Siegert prepared for his own use what he called "aromatic bitters," but, as they acquired much favour among his friends and the public, in 1830 he began to manufacture the bitters on a commercial scale, the first export to England taking place in that year. The bitters became known to the trade as "Angostura," from the name of the town on the Orinoco River where they were first made. On account of political disturbances in Venezuela the place of manufacture was changed in 1875 to Port of Spain, Trinidad. The present manufacture is controlled by a limited company, with an office in London.

Angostura bitters are made after a secret formula, which has been carefully guarded by the descendants and successors of Dr. Siegert, and the preparation apparently has never been successfully imitated since its invention in 1824. The concoction is understood to consist of a mixture of certain bitter aromatic and carminative substances, with alcohol added as a preservative and solvent. It has its most important use as a medicinal agent, but its best known use is as an ingredient in cocktails of all kinds. It is now much used also to flavour such temperance beverages as lemonade, ginger beer, ginger ale, and even mineral waters, and is occasionally added to fruit syrups, Christmas puddings, and mincemeat.

A temperance beverage popular in the West Indies, and one much used in the treatment of various tropical maladies, is Angostura barley water, made by adding a dash of bitters to a teaspoonful of barley, the juice of one lime, two tablespoonsful of granulated sugar, and two pints of boiling water. The chief medicinal value of the bitters is for fevers, ague, dysentery, cholera, and other intestinal troubles, and as a tonic.

Over half a million glass bottles are required in Trinidad every year in connection with the manufacture and export of Angostura bitters. Before the war these bottles were imported from Germany, but since 1914 they have been obtained from the United States, and great difficulty has been experienced in securing a sufficient supply of them to maintain the export trade in the bitters. The bottles are fitted with spray or sprinkler stoppers. The partners and managers of the business in Port of Spain personally do all the work of compounding the bitters, and only the work of filling the bottles and packing the cases is performed by their employees.

In Trinidad, in addition to the manufacture of Angostura bitters, there is a large production of various cocktail preparations, punches, swizzles, etc., in which the bitters appear as a flavouring ingredient, but cane rum, lime juice, sugar, and indigenous herbs of the West Indies and Venezuela

make up their main substance. Trinidad, indeed, seems to be the original home of the cocktail, and visitors there are amazed at the great number of different drinks which are served. (Even at church fairs and entertainments cocktails are offered at special bars.) However, the locally manufactured preparations, with the exception of bitters alone, are seldom exported, as the freight costs and import duties on such preparations are too heavy to make their shipment profitable ; and as rum, sugar, etc., can be readily obtained elsewhere, the cocktails can be made more easily and cheaply in the countries where they are consumed than the original beverages can be imported in bottled form from Trinidad.

THE COFFEE INDUSTRY IN PANAMA.

Panama presents a very favourable field for the growing of coffee, and there is quite a colony of foreigners, mostly Americans, situated in the district of Boquete, Province of Chiriqui, engaged in the industry; but the coffee lands of Boquete are limited and nearly all the good land is occupied. The best district for the raising of coffee is situated in the uplands of the district of Bugaba, where vast areas of the very best lands for coffee-growing exist and where climatic and other conditions are most favourable to its growth.

Coffee from this section is classified as the best in the world's market. Grown at an elevation of from 2,000 to 5,000 feet, it not only reaches perfection, but the altitude provides a healthy, cool, salubrious climate which cannot be excelled, the temperature ranging from 60° to 75° F. all the year round.

Boquete is the terminal for the national railway, and Concepcion, the capital of the Bugaba district, is the terminal of a branch of the same railway which provides transportation to the port of David, whence all products are shipped to Panama City.

After selecting a suitable piece of land, the timber is felled and generally burned, then the land is lined off and the young coffee trees are transplanted from a nursery which has been previously prepared, or with trees brought from a nursery. To prepare a nursery, the ground is properly cleared and the coffee berries are planted about six inches apart; in a few weeks the plants begin to show above ground. They may be transplanted at a year old, but generally at two years, after which they require two years to begin bearing, and at four years are in full bearing, averaging 3 lb. per tree. No shade is required in Panama, and the only cultivation consists in three or four cleanings a year to keep down the weeds, as no ploughing, etc., is necessary.

From a report furnished by the United States Consul-General at Panama City, it appears that coffee in Panama matures from October to January, and is then picked and taken to the factory, where it is fermented, after which it passes to the pulper where the outside hull is removed; then it is washed and dried, either by the sun or in patent driers. It is now known as pergamino, each bean being encased in a thin shell, which is removed by a sheller; it is then graded and bagged, ready for market. Water-power being abundant, this is used for running all the machinery, which is simple and requires no expert to operate it.

The annual output of the Province of Chiriqui, which produces the bulk of the coffee, is approximately 4,000 sacks of 100 lb. each, all of which is produced in the Boquete at present, as the coffee planted in the Bugaba section is still young and unproductive. The local supply does not meet the domestic demand, and instead of there being an export trade, a great deal is imported from adjoining countries.

Labour is plentiful and is paid at the rate of one dollar per day. Most of the work is done by contract. The cost of bringing a coffee plantation into bearing is about 70 cents per tree, and it is then valued at one dollar. This cost includes land, cleaning, felling timber, nursery, transplanting, and care. Most of the timber may be used for lumber, which commands a good price, as well as for the construction of all buildings. Catch crops may be planted between the trees the first two years. The climate is exceptionally healthful and the soil will produce anything planted, products of the temperate and torrid zones thriving side by side. In good soil 400 trees may be planted to the acre. The annual cost of maintenance is about 10 dollars per acre.

CORRESPONDENCE.

POWER FROM THE SUN.

The following letter is reprinted from *Nature* of December 18th:—

In the very interesting Trueman Wood Lecture delivered at the Royal Society of Arts on December 10th, Sir Oliver Lodge discussed the utilisation of solar radiation, and recommended, as the best method of effecting this purpose, the promotion of agriculture of every kind. According to Sir Oliver Lodge, the green leaves of trees and vegetables generally are able to absorb and utilise solar energy without much regard for any hampering limit to efficiency such as the second law of thermodynamics, but in saying this he appears to be unaware of the researches of Dr. Horace Brown, who has shown that the actual amount of energy stored is less than 2 per cent. of that which reaches the vegetation.

Now the total amount of solar energy intercepted by the earth is prodigious, being in the aggregate some 200 billion h.p., or, on an average, about 4,000,000 h.p. per square mile of that portion of the earth's surface that is exposed not too obliquely to the sun's rays. Absorption by the clouds and by the atmosphere, though important, is not so great as might be expected, with the result that even in this latitude and in this climate the energy

constantly received throughout the hours of daylight exceeds 1,000 h.p. per acre.

If, then, some method could only be devised for efficiently converting this energy into a form in which it could be readily applied for motive power and other purposes, the gain and the convenience would be enormous; for, to take a single instance, sufficient energy to run all the machinery in a factory throughout the working day could be collected from an area in many cases not greater than that subtended by the factory's roof.

Now, of course, for reasons which Sir Oliver Lodge fully discussed, it is hopeless to expect to be able to effect anything of this nature with the heat engine, for with this we should scarcely reach the 2 per cent. efficiency nearly attained by vegetation. But is there any need to allow the radiation to turn itself into heat at all? Solar radiation, as is well known, consists of electromagnetic waves in the æther—waves exactly similar in kind to those employed in wireless telegraphy. The only difference is that, whereas the length of the waves used in wireless telegraphy is a matter of hundreds or thousands of metres, the wave-length in the case of solar radiation is only a very minute fraction of a millimetre.

Even with wireless waves the resulting frequency is too great to allow of the electric currents they induce being directly utilised. The telephones and other instruments employed offer too much impedance to allow such currents to pass, while apart from this, no mechanical device could move with sufficient rapidity to respond to such frequencies. In wireless telegraphy, however, a method has been devised for converting these rapidly alternating or oscillating electric currents into currents which, though pulsating, are unidirectional. This is accomplished by the application of thermionic or crystal rectifiers or non-return valves, which only allow the currents in one direction to pass and suppress altogether the currents in the opposite direction. In this way the comparatively useless high-frequency oscillatory currents are converted into rapidly pulsating unidirectional currents which behave like continuous currents, and will operate telephones and other electromagnetic devices. Moreover, though in wireless telegraphy it is customary to use the currents in a single direction only, and to suppress the inverse currents altogether, there is no difficulty about utilising both currents by turning them into separate circuits with valves set opposite ways. Under such conditions, seeing that the separate valves let through their respective currents with but little loss, the efficiency of the conversion from the radiant energy absorbed to that utilisable in the form of electric current is quite high, probably not less than 50 per cent., and perhaps considerably more.

Is it too rash to suggest the possibility of some analogous method being applicable to convert into utilisable electric currents the electromagnetic waves of which the radiant energy from the sun consists? The method is quite successful with wireless waves having frequencies of millions per second, but can it be applied to the sun's waves, the frequency per second of which is of the order of billions? No doubt the problem is a difficult one, but we live in an age of marvels, and what would have been said of modern wireless methods only a few years ago?

One thing seems certain. The energy in the sun's radiation is there, and there, too, in most abundant quantity. To make use of it, moreover, requires no Maxwellian "demon" such as is necessary to render available the general stock of heat energy at uniform temperature. Nor, again, does what is suggested run counter to any thermodynamical law such as would preclude full advantage being taken of the great efficiency that is rendered possible by the enormous temperature of the sun.

Anyway, the problem of the application of solar radiation to the production of power otherwise than by means of heat engines seems worthy of attention, and is a problem that would appear much more likely to meet with a speedy solution than the difficult and obscure question of the liberation and utilisation of the internal energy of the atom.

A. A. CAMPBELL SWINTON.

66, Victoria Street, London, S.W. 1,
December 15th, 1919.

NOTES ON BOOKS.

COLOUR AND HEALTH: a Symposium. Edited by the Rev. John J. Pool, Ph.D., B.Sc. London: Cope & Fenwick.

To any informed person the abuse of colour in our homes and factories is little short of amazing. While attention is deservedly given to the technical quality and lasting value of the actual pigments and other applied decorations, a comparatively small amount of thought is lavished upon the value of the colour as colour. Only within quite recent years has a general appreciation of the value of the lighter coloured pigments arisen, with regard to their reflecting qualities for factory use, and as affording a chance of considerably reducing the lighting bill.

The finer intricacies of expert scientific factory management must inevitably lead the works manager to make at least some study of the finer questions regarding the value of environment in terms of colour, and for this purpose no better book could be recommended than "Colour and Health," a symposium by ten expert writers on various phases of colour, edited by the Rev. Dr. John J. Pool, Principal of the International College of Chromatics, which was instituted for the study of colour in 1916, at 3, Finsbury Square, and is the only institution of its kind in the world.

The facts of the medical use of colour, both for common mental cases as well as for the disorders arising from the war, are aptly quoted as affording evidence of the remarkable power of rightly used colour, whether as sedative or as stimulant. But

equally important is the fact, which the book does not stress as it easily might, that colour can also be used in ordinary life as a factor of actual value in commercial production. As speed in workshops necessarily depends on the fatigue ratios of the operatives' vision, it is obvious that the correct selection of colours and adjacent lighting will become an important factor. Which colours to select can be found in this volume. This is quite apart from the usual psychological value of colour, dealing with the mental energies of the human brain, for this system of colour selection impinges upon the emotional side, and has a subconscious and *continual* action upon the subject, while the other demands an act of attention to be of use.

In the present re-valuation of scientific principles, the vastly important facts of light and colour will not escape testing, and the business man of wide vision will lend a ready ear to those expert pioneers whose experiments have had such remarkable success. W. G. R.

GENERAL NOTES.

Sir William Duke. — Sir William Duke, G.C.I.E., K.C.S.I., has been appointed to succeed Sir Thomas Holderness, G.C.B., K.C.S.I., as Permanent Under-Secretary of State for India, and will take charge of his new post on January 1st, 1920. Sir William has been a Vice-President of the Royal Society of Arts and Chairman of the Indian Section Committee since June, 1916.

Barcelona International Fair.—An International Fair is to be held at Barcelona from May 15th to 30th, 1920, and in each succeeding year. Exhibitors must be producers, manufacturers, wholesale dealers, etc. Retailers and resellers are not admitted, and it is absolutely prohibited to sell retail or to deliver goods in the grounds of the Fair. Exhibitors can only book orders. Exhibits are divided into groups representing agriculture, horticulture, medicine, chemicals, mining, engineering, electricity, building construction and decoration, textiles, artistic industries, cutlery, jewellery, brush and toy making, etc. Exhibitors will have the benefit of facilities for transport and of modified customs duties. Application for certificates of admission and details of transport, customs duties, etc., should be addressed to La Direccion General de la Feria de Barcelona, Fernando 30, Barcelona, before January 15th.

Einstein's Theory: Seminar at Toynbee Hall.—The present verification of Einstein's theory of space and time has attracted the attention of those interested in scientific theory. It has been impossible, within the limitations of the press, to convey to the public what this theory implies. To meet the need felt to an increasing extent by a number of science teachers and advanced students for a deeper understanding of the principles underlying physical science, and especially the methods by which such principles are being formulated, Dr. S. J. Plimpton and Dr. F. S. Goucher, who are at present engaged in research work under the University of London and the Committee of the Privy Council for Scientific and Industrial Research, will hold a weekly evening seminar at Toynbee Hall during the winter, if it is clear that a sufficient number would like to attend such a course. It is not intended merely to cover the ground already undertaken by various technical institutions or to popularise the subject, but to present the philosophical and experimental processes by which progress in physical science is being made. The detailed form which the lectures will take will be determined to a large extent by the course of events and the progress made, but the course is intended to deal with dynamics, thermo-dynamics, electro-dynamics, the electron theory, the ether concept, principle of relativity, the quantum theory, and automic structure. Any who are interested should write stating the extent of their interest and their qualifications to the Registrar, Toynbee Hall, 28, Commercial Street, E. (1), and arrangements will then be made for a preliminary discussion between intending students and the teachers.

British Aircraft Competitions, 1920. — In connection with the British Aircraft Competitions for prizes amounting to £64,000, the following list of engines for use by competitors has been approved by the Air Council:—A.B.C. (all types), Boardmore (160 h.p.), B.H.P., B.R. 1, B.R. 2, Cosmos (all types), Galloway Adriatic, Galloway Atlantic, Galloway Pacific, Green (all types), Napier Lion, R.A.F. (all types), Rolls-Royce (all types), Siddeley Puma, Sunbeam (all types), Wolseley Viper. It will be left to the discretion of the judges to decide whether any new engine not included in the above list fulfils the conditions of the competition. The competitions will commence on the following dates:—Aeroplanes, small type, March 1st, 1920; aeroplanes, large type, September 1st, 1920; seaplanes (amphibians), August 1st, 1920.

Depth-sounding by Explosive Charges.—Some of the methods employed in the Navy for sounding the depth of the sea by means of explosive charges were recently described in *Le Génie Civil*. A small explosive charge is detonated in the water close to the vessel in motion. A microphone immersed to a slight depth and fixed to the boat at a known distance from the point of explosion first collects the detonation and then the echo reflected from the bottom of the sea. These two sounds are recorded on a chronograph, which permits the interval of time separating the two sounds to be read with great accuracy. The time interval and the mean speed of sound in the water being known, a simple formula gives the depth of the water. Experiments carried out in the Channel at depths between 60 and 100 metres gave very satisfactory results.

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FRIDAY, JANUARY 2, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

Wednesday, January 7th, at 3 p.m. (Juvenile Lecture.) Mr. Loughnan Pendred, M.I.Mech.E., Editor of *The Engineer*, "Railways and Engines." (Lecture I.)

The lecture will be fully illustrated with working models and lantern-slides.

Special tickets are required for the Juvenile Lectures, and no person can be admitted without one.

Further particulars of the Society's meetings will be found at the end of this number.

LIST OF FELLOWS.

The new edition of the List of Fellows of the Society is now ready, and copies can be obtained on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

FIFTH ORDINARY MEETING.

Wednesday, December 17th, 1919; Sir Henry Trueman Wood, Chairman of the Council, in the chair.

The Chairman, in introducing the reader of the paper, said Mr. Grunwald was a Russian who had lived in Russia all his life, and had an intimate acquaintance with its resources and industries. He had been one of the chief officials of the Russian Ministry of Trade, and since the war had been the principal organiser of the association which had been formed in London by Russian leaders of industry, and which was endeavouring to reorganise the trade of their country, so that when the happy time arrived when peace was at last established they would not be wholly unprepared. The paper dealt exclusively with industrial and economic matters, as the Royal Society of Arts was not the place for political subjects. He was sure those who took part in the discussion would bear that in mind.

The paper read was—

THE PRESENT ECONOMIC POSITION OF RUSSIA AND SOME ASPECTS OF ITS FUTURE DEVELOPMENT.

By Constantine Grunwald,

General Secretary to the Russian Manufacturers' and Merchants' Association in London, and late Chief of Intelligence Department, Russian Ministry of Trade, Petrograd.

It is rather a difficult thing to speak nowadays about Russia. The Russian problem has, unluckily, become a question of internal party politics, in this country as elsewhere; and if you treat the problem from the purely political point of view you get immediately entangled in a muddle of party interests and passions. If, again, you try to consider the events of Russia from a military point of view, you will come unavoidably to false conclusions. The civil war raging at the present time on the vast plains of the former Russian Empire, cannot be judged by experiences won in the late world-war struggle. Besides, one must necessarily agree with those who say that Bolshevism cannot be destroyed by the force of arms alone, and that ideas, however wrong they may be, cannot be killed by bullets. Finally, if one were asked to give nothing but practical advice to City business men interested in Russian affairs, one would find oneself confronted with great responsibilities as, under the actual position of Russia, it is rather difficult to expect the speedy realisation of great profits or revenues.

Still, I am indebted to the Royal Society for the Encouragement of Arts, Manufactures, and Commerce, for giving me this occasion to discuss before you the position of my country. Here, in this historic hall, I am able to take up the Russian question from an entirely impartial and broad point of view, as a problem of culture and economics, as a problem that does not

admit an immediate and full solution, but deserves close study and earnest appreciation.

To understand the present, it is always useful to go a little back in the past. In an old country like Great Britain, changes in the political and social structure come very gradually and in an almost imperceptible way. The development of a young country like Russia can be compared to the growth of a child—you do not recognise it if you have not seen it for a few years. That, by the way, explains why we have heard such contradictory opinions about Russia from people, and even very expert people, who have visited the country during different stages of her recent development; and it is needless to explain that, during the war and the revolutionary period, the quickness and briskness of those transformations have assumed an almost catastrophical character.

If you judge about Russian affairs, you must never forget that only some fifty-seven years ago the great bulk of the Russian nation was delivered from the bonds of a serfdom which amounted to something not very far removed from slavery. At that time Russia, from the point of view of economics, was a country living exclusively on agriculture of a primitive character, and furnishing to the world market nothing but the produce of farming or hunting. Only in the later part of the nineteenth century we see the birth of Russian industry and its rise by leaps and bounds. First of all there is the wonderful development of the cotton industry in the Moscow district—its pioneers were your countrymen from Lancashire. Then, simultaneously with the construction of the railways, comes the moment for the metallurgical industry in the Urals, and especially in the so-called Donetz district in the South Russian Steppes, between the Don and the Dniester. Then again, in the eighties, rises suddenly, like a mushroom, the cotton industry in the Lodz district, now belonging to Poland, and started mainly by German energy.

During the last years of the century the great statesman, Count Serge Witte, brought system into the industrial evolution of Russia, and led her with a firm hand towards an economic development in a purely West European sense. The foundation of a solid monetary system, a great railway construction scheme, the opening of Siberia, the influx of milliards of French and Belgian capital to the South Russian industry, a broad exploitation of the Baku oil fields, the appearance of Russia as the furnisher of manufactured products on the world markets of the Near, Middle, and Far East, are some aspects of the great work accomplished in the epoch of Witte.

Then, finally, after the first revolution of 1905, came a new and very interesting period in the economic life of Russia. Being aware that a chief reason of the political discontent lay in the poor material condition of the peasant class, the Government, led by Stolypin and Krivoshein, started a big scheme of agrarian reform by creating private ownership on peasant land, which was up till then in communal possession. This led to a very great increase of productivity in agriculture and farming. The amount of agricultural machinery sold in 1895 was 20 million roubles, in 1912 it was 110 million roubles. The value of grain production rose, in the same period, from one to four milliards. In the year preceding the war, the Department of Agriculture spent 30 million roubles for developing agricultural productivity—a larger sum than was spent by the Board for the entire period of forty-five years from 1838 to 1882. The butter export from Siberia, amounting to some 2,500 tons in 1898, was ten years later increased to 40,000 tons. However one may judge about the old Russian régime now overthrown by the revolution, it is hardly possible to deny that, in the domain of purely economical activity, it has done a tremendous work in developing the sleeping productive forces of the great empire. And it is certain that, on the eve of the war, Russia was at the beginning of a great ascending movement which, as some thought, might even have led her to a peaceful and gradual change from her antiquated political conditions.

But, of course, it was only a beginning. The great distances, the hard climate, the ignorance of the masses, were only some of the obstacles which prevented Russia from growing so quickly as to bear comparison with other more fortunate countries.

On January 1st, 1915, the length of Russian railways of general importance was about 50,000 miles, of which only 6.744 miles were in Siberia. The United States had in 1913 a railway system of over 266,000 miles; the population of the United States is, roughly, 97,420,000, and its area is 2,973,000 square miles. In other words, the United States, with a population, roughly, of only one-half, and an area of only one-third of the Russian Empire, has more than five times the mileage of railways. The *per capita* consumption of iron in Russia was considerably behind that of the other

European countries. While for Germany this amount was 319·8 lb., for Great Britain 269·1 lb., for France 245·7 lb., the corresponding figure for Russia was even in the record year, only 62·4 lb. The number of joint-stock companies in Russia barely reached 2,000, while England had more than 56,000. And even in agriculture Russia was far behind the other countries on the world market. The annual average yield of wheat per acre in bushels (1907–1913), was 10 for Russia, 14·4 for the United States, 16·8 for Rumania, 19·2 for Canada. Only Argentina approached the Russian level with 10·6 bushels per acre.* Finally, I should note that the number of men working in industry throughout the whole great country, with a population of 150 millions, was not more than 7 millions.

All these statistics prove the conclusion we arrived at beforehand, that Russia was just starting her industrial development. The capitalistic class was only in the stage of formation, the fate of the old Imperial Russia was ruled by a class of great landowners, officers, and noblemen, together with the so-called intellectual classes, both of them very far away from the great mass of the nation, and still farther from commercial and industrial interests. In this Russia grew up the brilliant literature that most of you know from the books of our world famous writers, the Russian opera music, and also the Russian ballet which now appear before me on the stages of this city like shadows of a long bygone past.

War and revolution have for ever stopped this whole period of Russian life. In Russia, as elsewhere, the immediate consequence of war was the mobilisation of millions of the best and strongest workers, an extremely intense exploitation of railways without regard to the necessary repairs (every wagon had to work about 40 per cent. more than in normal times); and thirdly, an inundation of the country by a flood of milliards of paper money. From about 1 milliard 700 million of roubles, the amount of paper currency had risen, on the eve of the revolution, to 17 milliards. The dangerous consequences of that phenomenon showed itself in Russia, just as in other places, only in the later period of the war. In the beginning the outlook was rather bright; first it looked as if war was going to make everybody wealthier; the mobilisation of industry, the storing of huge stocks of farm produce and grain for the army, gave to the manufacturers, as well as to the peasants, considerable profits which were, as a matter of fact, made illusory by the growing cost of production and living, and a gradual depreciation of the currency. Already from 1913 to 1915 the price of produce of the first necessity had risen by 53 per cent., the salaries only by 19 per cent. The normal production of a workman in the mining industry of South Russia had fallen, in the third year of the war, by 50 per cent., owing to the substitution of female and prison labour for the former stronger element. The want of a free outlet to the sea stopped the Russian export trade, and disturbed in a radical way the position of the Russian trade balance which was formerly excellent. The State revenues suffered heavily from the abolition of the spirits monopoly, which ranked formerly as the first item of the budget, and gave to the Government up to 80 million pounds a year. Last, but not least, a certain demoralisation, inevitable in wartime, spread itself widely between the capitalist and working-classes, awaking the spirit of profiteering known well enough in Western Europe.

The things I am telling about must be well known to your own experience. But how much more disastrous must have been the result in a country which was, as I have just said, at the beginning of her economic development! And it was on such ground—primitive in itself, shattered and loosened by the consequences of war—that the leaders of Bolshevism started, after returning from their exile at the moment of the revolution, the most daring of all economic experiments known to the world's history. I consider that British public opinion gets quite a considerable amount of information about the state of affairs in Soviet Russia. Some three or four weeks ago, looking through the morning press, I was sometimes inclined to think that I was living on the shores of the Neva and not on the Thames—nothing but Russia all round. And still I daresay there is a point which is not made clear enough to the public, which reads all about the atrocities of Bolshevik executioners and Red Guards, or about the amenities of the new proletarian paradise supposed to be created by Lenin and Trotsky. It is the consideration that Bolshevism is not so much a political as an economic creed. For one who has studied the theoretic foundation of Bolshevism, it is perfectly clear that Bolshevism means nothing else than an immediate and full application of the economic programme of Karl Marx. We have

* Dr. Joseph M. Goldstein's "Russia." (New York, 1919.)

been sometimes told, although I find it hard to believe, that the Bolshevists would be inclined to call for a Constituent Assembly of the Russian people. But I have never heard, and certainly will never hear anything, about even a partial revocation of this programme of nationalisation and State socialism, which is the essence of Bolshevist rule, and which has brought to Russia ruin and desolation. The question of nationalisation is an up-to-date problem in Great Britain too, and it is not for me to say how it will be solved in due time; but I know that nobody, even of the most advanced Labour leaders, has ever suggested the converting with one stroke of the pen, into State property and without any remuneration to the actual proprietors, of all the banking, industrial and commercial interests of the country—and that is what has happened in Soviet Russia in the first months of the Soviet régime. The High Council for National Economy, a beaureaucratic institution led by theoretical fanatics and ignorant labour men, is supposed to run in Soviet Russia the whole work of industrial production and distribution of internal and foreign trade, which is done elsewhere by the efforts of the private initiative and energy of tens of thousands of managers, directors and proprietors of individual firms. There has been talk recently of the possibility of raising the blockade, and the last session of the Trade Union Congress has pointed to the possibility of getting from Soviet Russia large amounts of various raw materials of great value for this country. Now the raising of the blockade might possibly be necessary from the political point of view—I have my opinion about it, but would prefer not to mention it. But I must say that the hope that this measure might open any possibility of exploiting the Russian market can be based only on an unconscious and possibly even conscious distortion of facts. With the best will in the world I cannot understand how the British merchant will carry out his operations in a country where private property is not recognised, and how the Bolshevik authorities may be able to fulfil their engagements and contracts when, up to the present, they have not succeeded in satisfying more than 5 per cent. of the normal consumption of the interior market.

The question of the practical results of the nationalisation scheme in Soviet Russia is an extremely interesting one; but time does not allow me to speak about it at satisfactory length. I must be content to draw your attention to a very impartial and well documented article of Mr. Robert Crosier Long in the November number of the *Fortnightly Review*. He will tell you that the deficit of the Bolshevik Budget for each month amounts to 60 milliards of roubles, and the loss from the nationalised industries another 10 milliards; that a branch of industry which paid in a single year 648 millions of wages has produced manufactured goods for 143 millions; how the scheme elaborated for distribution among the peasants of 600 million roubles of goods in the month led in reality to the distribution of goods for 75 million of roubles. I can only refer to the conclusion of Mr. Long that "regarded from all economical standpoints—volume of production, rate of employment, prices, and profits or losses—nationalisation has failed." And this is a conclusion which is confirmed by the experience of all who have lived, as I have, for a year or more, in Soviet Russia, and not only gone over to Moscow for a week-end journey. And as this nationalisation scheme is the essence of the Bolshevik system we can say without exaggeration that Bolshevism is slowly but surely approaching its final dissolution—a conviction shared by Lenin himself as he said that only a world social revolution can save Soviet rule. The much talked of Mr. Litvinoff confirmed the same thing a few days ago in Copenhagen. But, needless to say, the experiment made by Bolshevist vivisectors on the body as well as on the soul of Russia, was bound to give the saddest result in the actual economic position of that country. Everybody knows that Petrograd is suffering from real starvation, but the greatest scarcity is seen just as well in other towns even when they are nearer to the centres of production. Where there is grain there is lack of manufactured products. On July 1st they were paying in Moscow for a box of matches up to five roubles, for a pound of nails 800 roubles. The position of the railway transport is illustrated by the following statistics: the percentage of locomotives awaiting repair, which in 1913 was 16, was lately reported to be 47·7. Another report says that of 8,971 locomotives in Soviet Russia 4,728 need repair. The percentage of cars awaiting repair was in 1913, 3; in 1919, 16·6. The railway collapse is not due to financial cheeseparing; the expenditure rose from 705,000,000 roubles in 1913, to 7,300,000,000 roubles in 1918, and a profit of 470,000,000 roubles was turned into a loss of 5,500,000,000 roubles. And as to wages, the workman who formerly received some 50 roubles per month earns now 1,000 roubles,

but is certainly not better off than he was before.

The general aspect of these figures is such a gloomy one that they would really give reason to despair if they gave an entirely true picture of the actual economic position of Russia. Happily this is not the case. The normal instincts of healthy economic activity make way for themselves in spite of Lenin and his Supreme Economic Council. The greater part of Bolshevist legislation remains on paper. Read Calderon's comedy, "Life is a Dream," and you will easily find the analogy between Lenin and the hero of this play, who fancies for twenty-four hours that he is a king. When, as I told you before, the Bolsheviks' administrative machinery is able to satisfy only 5 per cent. of the normal consumption, you must not imagine that 95 per cent. remain unsatisfied. The population gets supplies—of course very much reduced—in an illegal way. You cannot get nails in the Soviet shop, but a boy will be standing outside in the street offering you those same nails in a surreptitious way, and this boy is, as a matter of fact, the clerk of a great commercial organisation spreading all over the town, and conducting a secret trade in this or that article. Hundreds and thousands, if not millions of peasants, attracted by high profits, carry sacks containing farm produce to the great consumption centres literally by the sweat of their brows, and that is the strange result of this Government monopoly of every trade, that it creates this new very enterprising and energetic class of men who are to-day "sack bearers" but will be traders to-morrow. The Soviet people send around in the village districts pamphlets about the obnoxious activity of these capitalistic joint-stock companies, and the peasant who has never heard of such an institution before says, "That's a good thing; I should like to have some shares," and makes a contract with the owner of a mill, converting it for the moment into a communistic socialistic property bound in due time, when the Bolshevists are gone, to be further converted into a joint-stock company. And so, after all, the fight against capitalism, which was more or less non-existent in Russia, creates interest for capitalism and possibly a new class of small capitalists.

And then there is another thing that should never be forgotten. The Bolsheviks have never been the rulers of the whole of Russia. In spite of their recent military successes, even now half of Siberia, the western boundaries of Russia—with all the newly-formed States—and practically the whole south of the country together with the Black Sea shore are not in their power. And to understand the economic importance of South Russia it should be remembered that its exports include one-third of the total Russian grain production, five-sixths of the sugar production, one-third of the meat production, 70 per cent. of the coal production, and 60 per cent. of the pig-iron.

Of course, in all those territories the more or less prolonged invasions of Bolshevik armies and the subsequent state of civil war have left very deep traces. The saddest of all this is that it has slackened the respect for honest work as well as the feeling of responsibility of the individual to the State and society. The second symptom is the extraordinary position of the rate of exchange; a pound sterling that was worth nine roubles before the war, and a hundred roubles this spring, is now exchanged for 800 or 1,000 roubles. The prices of all commodities are extremely high. In Tangarog they paid in the beginning of November for a yard of woollen cloth about 600 roubles, for Cheviot tweed 1,200 roubles, for officer's boots not under 3,400 roubles, for butter 100 roubles per pound, for bread 5·50 per pound, for eggs six roubles a piece. This district seems to me to be in a rather disadvantageous position; in Rostoff the prices may be about 50 per cent. lower, but even this is a very poor consolation. The root of all these evils is the very bad condition of the railways, the lack of repairing materials for the rolling-stock, the bridges and so on, and the subsequent possibility of transferring the merchandise to the ports and consumption areas. I think that many of the Englishmen who have recently gone to South Russia have been too strongly impressed by all those facts. I do not conceal them from you, but I want you also to look at the other side of the medal. Private property and legal security are re-established in Southern Russia. The country has had the benefit of a harvest that has been a record for the last thirty years. There is unanimity in stating that from 10 to 15 million tons are available for export only. The coal mines are exploited, owing to the lack of transport facilities, only to 25 per cent. of their normal production, and give now not more than one million tons a month. Any increase of the production can give huge quantities for export, and the same is true of iron ore. I should think that the extreme scarcity of these products in Western Europe should prove in itself a sufficient reason to

undertake the most heroic measures for re-establishing a normal economic activity in Southern Russia. And if General Denikin has up to the present not entirely succeeded in achieving his great task, it must be borne in mind that he began as chief of a great military organisation which wished to postpone the question of government and interior reorganisation on broad lines up to the moment when the Bolshevik régime would be overthrown. By this time it is clear that the task is not so easy as it seemed to be. The economic theories of the Bolsheviks, based on theoretical and abstract principles, must find themselves confronted with other economical programs, dictated by practical considerations and a real knowledge of the needs and resources of Russia. And the day that this happens we shall see the final collapse of Bolshevism and the regeneration of Russia.

This regenerated Russia will be something very different in its social structure from the country I spoke to you about in the beginning of my paper. I mentioned there the old ruling class of Russia, a class of military gentry and *intelligensia* that created the old Russian culture with all its defects and qualities. Now it will be superseded by other classes. The revolution has brought with it a violent process of the liquidation of great landed property which has passed now into the hands of the small peasant farmer. The Bolshevists are here for nothing. They wanted to convert the land into communal Soviet property, practically " No Man's Land," but that never succeeded; and they did not insist particularly, as Marx's theories on the question of land nationalisation are not quite explicit. Only last week a wireless from Moscow announced officially that out of the 23,000,000 desyatine (about 100,000,000 acres) of gentry property only three millions are run on communistic lines, the rest passed into the hands of the peasants as private property. Of course, all this is nothing but a great organised robbery. But we saw the same thing during the French Revolution. And everyone of us knows that the land will not return to the original owners. They might recover part of it; they certainly should receive some material compensation. But anyhow the peasant will remain what he is now, " the great master of the Russian land," a title that formerly belonged to our Emperor. And the Russian peasant having increased his property and having learned very much in the last five years, more than probably one realises now, having acquired as I told you new commercial and industrial tastes, will ask for an ever-increasing share in the government of the country and the ruling of its destinies.

At the same time it is very certain that the importance of that part of the Russian population, which could be compared to the British lower middle classes, will also go on increasing. I think that at the present moment they have a great part of the decisions in their hands, vacillating as they do between the different fighting forces, hating Lenin and unwilling to support Denikin. From the economic point of view we might say that they are grouping themselves around the so-called co-operative organisations. I am not inclined to exaggerate the importance of this famous co-operative movement, which has been fostered by accidental causes; first a great supply of Government money, and then under the Bolsheviks the impossibility of destroying co-operation owing to its purely democratic character. By being too enthusiastic about co-operation in Russia we run the danger of injuring private individual energy, which is, as a matter of fact, of the utmost importance. But still I cannot deny the healthy foundations and the wonderful progress of this great Russian co-operative movement. As I find in the most interesting report of the Canadian Trade Commission on Serbia, given to me by Mr. C. F. Just, the membership of co-operative organisations adherent to the Centrosoyouz, or the All-Russian Central Co-operative Union, amounts to 25,000,000 persons. This Centrosoyouz serves about 500 districts, associations having 40,000 stores of their own for distribution of products among the population.

At the present time the Centrosoyouz has joint stock amounting to about 10,000,000 roubles, capital stock of about 5,000,000 roubles, over 20,000,000 roubles in movable property and real estate, particularly in its own industrial establishments, and about 300,0000,000 roubles in floating capital. The turnover amounts to 9,000,000,000 roubles.

In 1917 the commercial transactions of the Centrosoyouz reached the sum of 250,000,000 roubles, while last year, 1918, the sum amounted to 1,000,000,000 roubles. And as a curious phenomenon I should like to note that many repentant revolutionaries, too moderate for following the Bolshevists, have joined now the co-operative movement, and are to be found among its most energetic workers.

But the actual guidance of the two above-

mentioned classes, which are both yet far from being politically ripe enough, will find itself in the hands of the *bourgeoisie*, the employers, the factory owners, the leaders of great concerns. As I told you these are yet few, but they are bound to become every year stronger and more numerous. Many of the best representatives of the old nobility will almost surely adapt themselves to the new conditions by joining this class. From this point of view, as from others, the development of Russia will take the same course as the development of other countries, where the rule of the *bourgeoisie* followed the rule of the nobility.

It is beyond doubt that the joint effort of those new classes, which are now coming slowly but surely into the power of Russia, will have one and practically only one aim—the development of the productive force of the country.

And this leads me to talk about the possible future perspectives. Needless to say, they are tremendous. The first part of my paper gave some material to form a judgment on this question. Take the problem of agriculture. In 1912 there was under cultivation of the entire land area of European Russia 17·5 per cent., and throughout Russia only 5·2 per cent. This means that 95 per cent. of Russia's land area was uncultivated (40 per cent. under wood, 20 per cent. swamps and rocks), and still the cultivated territory is five times greater than the cultivated territory of Germany. I gave you above the comparison between the harvest results of Russia and some oversea countries. If we compare the average yield of Russia with European results we see that they are about three times less than in Germany or Great Britain, and more than four times less than in Denmark (the annual average wheat yield for the period of 1901 to 1910 in poods per desyatine was: Russia, 45; Germany, 130; Great Britain, 148; Denmark, 183). Those poor results are explained by an extensive culture insufficiently provided with machinery and fertilisers. Germany spends on artificial fertilisers 400 million of marks a year, Russia —ten times less on a space that is five times as great. If we would bring the harvest of Russia to the average yield of Austria or Bulgaria—*i.e.*, 80 poods the desyatine—a certain possibility—that would give a surplus of grain of 25,000,000 tons a year. Enormous spaces of agricultural Russia are, if cultivated, exploited for local needs only. Siberia has transported by rail only 1·3 per cent. of her grain production, the rest remained on the spot. The position can be entirely changed by creating in Siberia granaries and elevators for keeping and drying the grain which is generally collected during the wet autumn season. Siberia has practically not yet entered into the world market as a grain producer. And in spite of all this Russia was already one of the world's principal producers of grain. According to estimates made by experts, she produces 51 per cent. of the rye, 25 per cent. of the oats, 33 per cent. of the barley, and 22 per cent. of the wheat grown on the surface of the globe. What importance it would have in the world's supply if Russia reappeared again as furnisher of grain in quantities twice as large as those just named! And what a change in the rate of exchange in this country if she could get her supply of grain from Russia in barter for manufactured products, instead of making daily increasing payments of legal tender to the U.S.A. and Argentina!

The same wonderful possibilities are to be found in the domain of farming. The last ten years before the war, the Russian export of butter and eggs went on increasing in a geometric progression and amounted finally for each of these products to £8,000,000 or £9,000,000 yearly. And yet Russia, the classical land of cold, was extremely badly furnished from the point of view of cold storage and refrigerating cars. Whereas the U.S.A. had over 100,000 of these cars, the number in Russia amounted in 1914 to 3,414, and as every Russian wagon could bear only fifteen tons against thirty in the U.S.A. the facilities of America were sixty times those of Russia. The U.S.A. had, in 1914, 19,000 cold storage plants and Russia only 407. Needless to say, the re-organisation of Russia from this point of view would lead to a very great increase of her activity in the domain of farming. Practically every new great plant creates a new local production, as has been shown so well by the experience of the British firm of Westley Bros., who brought to life the bacon industry in Kougan and the export of eggs from Tambov and Kosloff. The increase of Siberian butter export was in full parallel with the increase of the number of refrigerating cars. The importance of Russia as producer and exporter of meat has been up to the present infinitesimal, in spite of the enormous steppes of Western Siberia and other parts of the great country. The lack of refrigerating plant was one of the main reasons. On the Russian railways meat was transported only in winter time, and in the other seasons cattle were

brought to the production centres alive, which was four times less advantageous. And as to the number of cattle, Russia had only 390 head of cattle per 1,000 inhabitants against 5,320 in Argentina and 4,600 in Australia. Shortly before the war there had been elaborated a big scheme of refrigerating installations on the ways from Siberia, Turkestan, Caucasus and Crimea to Moscow and Petrograd. The execution of this scheme, which was estimated to cost 45,000,000 roubles, should certainly be taken up one day, as it is sure to bring a very considerable quantity of butter, mutton, fruits and fish to the Russian consumption centres and to the world market.

Now a few words about timber, which, after agriculture, occupies the second place of importance in the natural resources of the Russian Empire, and the second place, after wheat, in value of exports, having increased from a total of £6,500,000 in 1905 to £16,500,000 in 1913. I want first of all to remind you that Russia accounts for nearly 50 per cent. of the grand total afforestation of the world, without including the vast areas of unexplored forests in Siberia, and that of the total exports of Russian timber, Great Britain has taken 40 per cent. in bulk and in value. It would lead me too far if I entered into consideration of the possibilities of an expansion of the Russian timber trade, given a rational exploitation of the vast forest territories of Archangel and Siberia, and the amelioration in the conditions of the water-ways. I will content myself by saying that the possible annual export of lumber from Siberia may be put at about 6,120,000,000 cubic feet; the licensed annual export specified on Government permits in districts accessible for exploitation under the present system of transportation is 1,351,000,000 cubic feet, whereas the actual amount utilised hardly reached, in 1918, 18·5 of the licensed amount, or 251,000,000 cubic feet, and only 4·1 of the possible amount: 96 per cent., 4,700,000,000 cubic feet of timber in Siberia, is left entirely unexploited.

If we turn to other industrial activities the same limitless horizons open before us. The importance of Russia as a producer of copper, oil, platinum, asbestos, is known and must not be underrated. In the domain of cotton Russia produced in 1914 1,300,000 bales, more than half of the consumption of her mills, and still Russia had only a share of 3 per cent. in the world production, and the per capita consumption of cotton in Austria-Hungary was from 40 per cent. to 45 per cent. greater than that of Russia, whereas that of France or Germany was about three times that of Russia. Cotton-growing has a great future in Turkestan, depending almost entirely upon the increase of irrigated lands. Practically only 250,000 acres have been supplied with water, whereas the land available for irrigation is estimated at 7,500,000 acres. To close this enumeration I want to point to the great possibilities of expanding the coal and mining industry in Southern Russia. The matter is a most important one, as the needs for metallurgical products for rails, agricultural machinery, roof-iron, etc., as well as for fuel in different branches of industry, will be felt in an extremely acute way. Before the war Russia produced 4,644,000 tons of pig-iron (67 per cent. of which came from Southern Russia), while the existing equipment of the blast-furnace plants would suffice to bring the smelting of pig-iron up to approximately 6,000,000 tons, which would exceed the maximum of production reached up to this time by almost 30 per cent. And if one began to construct new plants the possibility of getting raw material would not present the slightest difficulty. The iron-ore deposits for example in the Krivoi-Rog district are estimated at 100,000,000 metric tons. In the Urals one mountain alone, the Magnitnaya, has resources of over 100,000,000 tons of ore. For coal which was produced before the war in a quantity of 30,000,000 tons yearly, the prospects are just as good. Since the discovery of the Donetz coal basin only 2 per cent. of the total deposits have been utilised.

I am afraid that you might accuse me, after listening to the remarks I have just made, of entering into the domain of phantasy. I could reply to you that all my statistics are based on official censuses, verified by scientific research; but I cannot deny that I am speaking about what we call the music of the future, and I prefer to return into the realm of the sad actuality. And this actuality is so moulded that before starting any scheme in any of the directions enumerated the future Government of Russia will have to solve four extremely complicated economic problems. I do not speak about the re-establishment of a legal government in Moscow, which is the preliminary condition to any reasonable work.

I speak first of all about the question of denationalisation, which is not a simple affair at all. I cannot agree with Mr. Crozier Long, who goes so far as to declare that "the precipitate tearing down of the central Council for national economics and its ramifications would

produce even greater anarchy than Bolshevism produced out of the former capitular industry"; but I cannot deny the difficulties in returning quickly to the old individualistic order of things, in evaluating and repaying capital which has been spent by the Soviet authorities in a right or wrong way to run the industrial enterprises which they have nationalised, etc. A special interest will be certainly evoked by the position of nationalised banking. To consider all private Russian banking institutions as bankrupt is decidedly wrong. Professor Goldstein, in his new book about Russia, shows very clearly that the only harm that the Bolshevist could have inflicted upon the commercial banks was the confiscation of the ready cash, which, at the time of the *coup d'état*, was found in the vaults. These cash funds, however, were quite negligible in amount. "Thus, for instance," says Goldstein, "on May 1st, 1917, all the cash on hand in all the Russian joint-stock commercial banks amounted to hardly 183,000,000 roubles. The actual losses suffered by these banks from the Bolshevist confiscation, which occurred several months later, were even smaller, for, after their victory, the Bolsheviki continued to pay out to depositors on current accounts, in the beginning, at the rate of 650, and later at 1,000 roubles, per month. Besides, they also paid out very large sums from current accounts when these went for the payment of workers' wages, clerks' salaries, etc., in various industrial plants. Thus the cash losses of the private commercial banks were considerably offset by the payments made by the Bolsheviki upon current accounts of the private banks from the funds of the State Bank."

Then again one must not lose sight of the fact that the depreciation of the rouble reduces the liabilities of the banks to a negligible sum, whereas their assets, which consist, in large measure, of controlling blocks of stock in important industrial enterprises which own valuable mines, oil lands, and vast tracts of timber lands, are bound to increase immensely in value.

On the other side, it is impossible to minimise the importance of the heavy shock that the banks will have suffered. But their expansion and the establishment of new banks will have probably very good chances, the more as Russia had one branch office only for every 250,000 of population, as against 2,400 in Canada.

The second and third problems are still more difficult and complicated. They are the establishment of a healthy currency and the reorganisation of railways. To-day it seems that practically everybody is printing money in Russia. How much has been printed by all the different governments and armies nobody seems to know. In the report of the Canadian Trade Commission I have found the following estimate of currency outstanding, made at Omsk on March 28th by Mr. Michayloff, Minister of Finance in the Siberian Government. He stated there are now outstanding, according to figures furnished the government :—

1. Of the Romanoff and large denomination Kerensky note issues—35 milliards of roubles.

2. Of the Kerensky issues of forty and twenty-rouble notes—70 milliards.

3. Of the Imperial, Kerensky, and Bolsheviki bonds and Treasury bills—20 milliards.

4. Of the Siberian (Kolchak) Government issues and Treasury bills—1½ milliards.

A total of 126½ milliards of roubles. This is exclusive of local and municipal issues, estimated at 200 millions.

Since then the amount of paper money has considerably increased, and amounts to-day probably to about 200 milliards. I do not know if there will ever be a possibility of raising the value of the old rouble to some reasonable figure. Serious economists are, as I see, inclined to think that a new monetary unit will have to be established. It would lead me too far if I entered into any detailed discussion of this question. I should like only to point out that the question is extremely aggravated by the monetary crisis of the whole world; formerly it was an axiom that there must be a very definite correspondence between the paper money and the gold, and we were, in Russia, extremely proud of our gold fund, of 1·5 milliards of roubles—the greatest in the world. To-day nobody can tell in a definite way what the real foundation of a healthy monetary system is. I read the other day in the final report of the Cunliffe Committee, that the adoption of a currency not convertible at will into gold, or other exportable coin, is "likely in practice to lead to other issues, and so to destroy the measure of exchangeable value"; but this indication of a competent board of specialists seems to me to be vague enough. Under those conditions, when nobody practically knows what ways will be taken by the future evolution of the currency problem in Europe, it is probably premature to offer remedies specially for Russia. But one thing can be said with certainty,

Russia will not be able to solve the problem without active aid from outside.

As to the question of amelioration of transport conditions, there is no need of any further explanation of its necessity after all that I have said. This problem is certainly the most urgent, and, as it admits a partial solution in the non-Bolshevik parts of Russia, should be taken up at once. I must repeat again that the only way of utilising the resources of Russia for the world's market is to help her in the re-establishment of her rolling-stock, in the reconstruction of bridges, and in the bringing into order the lines and stations. If Russia could get in sufficient quantities of new rolling-stock, or even the tools and parts for repairing the old she could start at once with her economic activity.

And now I come to the last and most serious of the four mentioned problems. It is the question of reconstruction of the Russian national unity. If we take the question from the purely economic point of view, the legal position of the new boundary States has a somewhat secondary importance. Those States might call themselves as they like, autonomous, or even free. But close economic unity with Russia in its proper sense is a primordial necessity to any of the parts of the old Russian Empire. Central Russia cannot live without an outlet to the seas, she cannot exist without fuel from the Black Sea shore, sugar from the Ukraine, cotton from Turkestan, butter from Siberia, etc. As to the position of the Baltic border States, it is from the economic point of view quite impossible that they can lead an independent life.

A correspondent of the *Daily Chronicle* said the other day in a telegram about the position of Estonia, which he calls poetically "a child born in the thunderstorm," that apple-growing, poultry-farming, pig-keeping and dairy-farming, are branches of agriculture which are being enthusiastically developed there. But all the enthusiasm cannot change in my eyes the fact known to every Russian that Estonia is a country extremely poor in natural resources, and producing mainly potatoes. And even with the addition of some apples or some poultry I am afraid that her ground would not produce sufficient food for her own population. As a matter of fact, the greater part of the wealth of the Baltic Provinces was due to an extensive exchange of goods that passed through their port, but came from other provinces of Russia.

I am sorry that time does not allow me to deal with this question of the economic unity of Russia at greater length. I must content myself by saying that Russia was a great living economic organism, and the old Roman fable about the interdependence of the members of a body, and the body of politics, remains for ever true. You can cut off my arm, and it is possible that my wound will be healed, but my arm cannot continue to lead an independent life.

The question of economic unity is entirely dependent for its solution on the goodwill and support of the great Powers—more, possibly, than the other three questions already mentioned.

Now, I ask you, who is going to help Russia in the solution of these great problems? It is evident that the Germans cannot be kept away from Russia, their nearest neighbour, and practically their only source of supply. Sir Bernard Pares, the great supporter of Russia in this country, tells it plainly in a letter just published in *The Times*, but at the same time he points perfectly rightly to the great danger that would be connected with the policy which would surrender Russia to German monopoly, and which would give to Germany the full control of Russian raw resources and Russian man power. Germany will not fail to take her part in Russian affairs, but why should it be the leading and all-absorbing part? It depends on British public opinion to decide this question. I had yesterday the privilege of assisting at a meeting in the House of Commons, where leading authorities in British Governmental and political life expressed unanimously their conviction of the necessity of British relief for Russia, especially South Russia—of a relief not only humanitarian, but also of an organising and commercial character. I earnestly hope that the aims of those noble and generous friends of this country will be realised, and that this country, which was the foremost in the struggle for freedom and civilisation, will play the same role in the work of reconstruction in Russia.

DISCUSSION.

MR. D. T. CHADWICK (Indian Trade Commissioner) said he could not claim a close or very recent connection with Russia, as his residence there had been brief; but, short though it was, it had stimulated his interest in that great country, and no one whose interest in Russia had once been aroused could ever lose it. They were all very much indebted to Mr. Grunwald for his excellent paper. It was a good thing to be reminded of the main outstanding facts with regard to Russia, unobscured by the temporary changes

which went on from week to week. Mr. Grunwald had done well to lay stress on the inherent riches of his country. In spite of the sort of ebb and flow which was manifest throughout the history of the world, the resources of one country after another had been brought into play as they had been needed by the world in general. At the present time the agricultural products and large mineral resources of Russia were urgently needed. It was a calamity that they were now so largely unavailable. But safety and confidence were necessary for trade. Mr. Grunwald seemed to anticipate that in the future a greater activity would be shown in the economic world by a larger class than formerly; it almost seemed as if he expected individualism to succeed communism; and if that was the case it would probably lead to a big development in Russia's commerce. Such a development would be of interest to India, because the products which India exported went into general consumption in most countries.

Mr. C. F. Just said that during his residence in Russia he had only been concerned with the development of trade relations between Canada and Russia, and had therefore not acquired so wide an outlook as those who had dealt with the country from a broader point of view. Canada was mainly interested in Siberia. Mr. Grunwald had touched upon the enormous potential resources of Siberia, and it was with that country that Canada hoped to find a great opening for the exchange of her products. In its agricultural and mineral wealth Siberia was very similar to Canada, and the experience which Canadians had had in developing those resources in their own country led them to believe that they could participate in the development of Siberia with profit both to Siberia and themselves. In view of the disturbed condition of affairs in European Russia, he thought they should concentrate upon Siberia for trade purposes. Siberia had been less disturbed than any other part of the Russian Empire, and the Bolshevik movement there had only been sporadic, and had been easily suppressed. The recent invasion of the Red troops might revive it for a time, but he doubted if that invasion would have any permanent consequences, on account of the attitude of the Siberian population. That population had been formed by emigration from Russia, and the sturdier elements of the Russian people seemed to have gone there, so that the Siberians were characterised by great self-reliance and independence. They had been remote from the centralised administration of the old régime, and the paralysing arm of bureaucracy had been less felt there than in European Russia. The reorganisation of trade with Siberia should be carried out by combined rather than by individual effort. There were a number of important British interests in Siberia which could be linked together to form a chain of posts throughout the country, and could deal with the trade position both with regard to exports and imports. Owing to the great depreciation in Russian currency, it was impossible to obtain payment in cash for imports, but by collecting produce and exporting it against imported goods a system of barter could be introduced to the advantage of all concerned. The two great obstacles in the way of a renewal of trade with Siberia were the transportation and the currency questions. The transportation question had been tackled the previous spring by an Allied Technical Commission working in conjunction with the Russian railway administration, and in Siberia the state of affairs had already been materially improved; and although it might take some months before normal conditions were re-established, things were tending in that direction. The currency difficulty could be largely overcome by the system of barter he had suggested, and the position in that respect would be greatly eased by improved transportation. He was glad Mr. Grunwald had referred to the Co-operative movement in Russia. Personally, he thought it would prove the principal factor in the economic regeneration of Russia.

Mr. E. A. Brayley Hodgetts said they had all listened with the greatest pleasure to Mr. Grunwald's very able paper. The remarks he proposed to make were not in any way intended to be personal, and he hoped that Mr. Grunwald would not take them as such. In order to appreciate properly the commercial development and history of Russia it was necessary to understand that the curse of that country had been her bureaucracy. There had been eminent exceptions, but speaking generally the bureaucrats of Russia had done their best to prevent the people from developing their industrial and commercial resources. Although they had not consciously sought to prevent that development, they had been afraid of allowing the people to do it themselves, and that was why they had opposed the co-operative movement so strongly; they saw in it a threat to their own existence. Until 1861 the majority of the population of Russia were serfs, who were managed by their masters, the landowners, when they were not owned by the State. The people lived under patriarchal conditions, and there was practically no officialism at all. The Emperor was far away, and it was to the interest of the landowner to keep his serfs contented. When an official visited the neighbourhood he was driven away by bribes. In 1861 that system was upset, and the old system of co-operative working was re-stimulated in Russia, for the peasants had always tilled their ground on co-operative lines, and during the long winters when they could not work at home they would band themselves together and go to the neighbouring towns and work in the factories, pooling the wages they earned there without reference to the amount each man had received. That was the beginning of the co-operative idea. The idea of co-operation was rooted in the Russian

people. When the freed serfs tried to sell their produce they were met on their thresholds by the profiteer, the koulak, or fist, as he was graphically described. He had them in his power and was able to dictate the price at which they should sell their produce to him, and the price at which they should buy from him such articles as they required. The co-operative movement was a movement to get rid of the profiteer. The co-operative movement *per se* was a purely economic movement, although no doubt there had been politicians who had seen that it might be used to their advantage for political purposes. By organisation amongst themselves the peasants had been able to improve their selling prices, and had even erected granaries and engaged specialists to show them how their methods could be improved, and had also adopted a system of co-operative buying. Gradually the single societies combined and formed great unions which became a danger to the State because they threatened to monopolise every form of economic activity to the exclusion of private enterprise. One of the causes of the Revolution was the friction between the bureaucracy and the co-operative societies and county and municipal councils working together. The co-operative societies stood for self-help, and it was by self-help, and not by the creation of an army of officials, that Russia would be regenerated. One of Russia's difficulties was that the educated classes were not sufficiently numerous; with a large bureaucracy they nearly all became officials, and there was nobody left to run the business of the country. The old-fashioned Russian merchant was entirely uneducated, though a very decent and honest person, with a strong admixture of shrewd cunning. The Revolution had swept away that class altogether, and had substituted for the tyranny of the old bureaucracy the tyranny of the Commisars. The first thing to do was to encourage self-help among the Russian people, and the next to bring about some method of intercommunication. Although the population of Russia was estimated at 185,000,000, we had no means of communicating with them; there was no proper postal or telegraphic service, even with the South of Russia. Constantinople was administered by a British High Commissioner, who was most anxious to promote good relations with the whole of the Black Sea littoral; but in spite of that a letter took two months to get to South Russia, and was very often lost when it got there; and the idea of expecting a reply was fantastic. It was impossible to cultivate commercial relations as long as that state of affairs existed. Mr. Grunwald had said much in praise of Count Witte. Nearly twenty years ago, as their Chairman might remember, a paper was read before the Society on the Iron Industry of Russia,* in which they were told how Count Witte had created that industry in the South of Russia by promising large orders for rails, and how, when it became inconvenient for him to continue his railway policy, he had stopped those orders and had said to the manufacturers: "You have been established for five years, and now you ought to have built up a business for yourselves." Count Witte omitted to add that their only customer had just dropped them; and the result was that the iron industry of South Russia was temporarily ruined. It was always unhealthy to have a government-fostered industry, stimulated by artificial means: a healthy natural development was much better. If an artificial development was successful—and in nine cases out of ten that was not the case—it became a danger not only to itself but to the whole world, as illustrated by the example of the German Empire.

* "The South Russian Iron Industry." By Archibald P. Head, M.Inst.C.E. *Journal*, December 19th, 1902.

MR. ALEXANDER ONOU (Russian Consul-General) said that the only objection he had to find with the conclusions at which Mr. Grunwald had arrived in his very interesting paper was with reference to Germany. Mr. Grunwald had quoted a statement of Sir Bernard Pares to the effect that if the British Government did not take a certain course in favour of the anti-Bolshevik forces there was a risk of Russia becoming a German colony. He thought that was a mistaken idea. Even at the present time Russia was a formidable force. That force was minimised by the internal struggles which were taking place, but if the Bolsheviks had only to fight Poland, or even Germany, instead of Denikin, the world would see how strong they were; and if Denikin, instead of struggling against the Bolshevists, was fighting against one of the other European nations the same result would be apparent. Russia was weak only because it was torn by civil war. A year after that civil war ceased Russia would be strong again; and immediately after the first good post-war harvest Russia would be rich again. The Russian people were intelligent, and knew how to help themselves, and their country was strong; there was, in any case, no danger of Russia becoming a German colony. The real danger lay in the fact that after the war the pro-German party in Russia—it was idle to deny that such a party existed—would wish to trade with Germany rather than with Britain or France or America. It was to the advantage of the Allies to help Russia in her present difficulties. The only nation at present helping Russia was Great Britain; and it was to Great Britain's advantage to continue to help Russia with money and necessary goods, so that when the civil war was ended there would be in Russia a general feeling of gratitude towards Great Britain, and the pro-German party would be thus weakened.

THE CHAIRMAN (Sir Henry Trueman Wood) said he had great pleasure in proposing a very hearty vote of thanks to Mr. Grunwald for his interesting and valuable paper. He was sure it was the hope of all in this country that Russia might soon again take her proper place among the nations under whatever form of Government—

provided it was a civilised Government—her people chose to adopt. The work which was being done by the Russian Manufacturers' and Merchants' Association in London—which was really a sort of Chamber of Commerce—would help towards that end; and he hoped that before very long they would be able to resume trade relations with Russia. Russia had been a good customer of England's in the past, and produced great quantities of raw materials which English manufacturers were anxious to obtain. He hoped that the paper which had been read that afternoon would contribute towards that happy event, and they were all much indebted to Mr. Grunwald for delivering it.

The vote of thanks was then put and carried unanimously.

MR. GRUNWALD, replying to the discussion, said that the Consul-General (Mr. Onou) had dealt with the Russo-German situation more fully than he had been able to do in the time at his disposal; personally, he had rather avoided it as being a political question. He would be only too glad if Mr. Onou's optimistic predictions as to the rapid recovery of their country proved to be correct. With reference to Mr. Just's remarks about Siberia, when a man's house was burning down he did not pause to consider by which door he should enter to put out the flames. He would like to point out that South Russia was nearer to Western Europe than Siberia, and required the greatest attention, and it was in South Russia that the political and military anti-Bolshevist elements were chiefly concentrated. He thought that Great Britain should pay the greatest attention to South Russia, while not neglecting Siberia. He would be the last to deny the importance of the co-operative movement, and the statistical data he had given would show that he was impartial in the matter; but private initiative and enterprise had to be encouraged in Russia, and the fostering of one movement should not be allowed to hamper other movements. The activities of the municipal and county councils in running mills, making trade, and so on, were due to the abnormal conditions prevailing in Russia. He would like to see those things done in the future in Russia, as they were elsewhere, by private enterprise. As to the bureaucracy in Russia, to which one speaker had referred, in view of what had taken place in that country since the Revolution the only thing for every single man to do—no matter what class he belonged to—was to go down on his knees and say *mea culpa*—the bureaucracy not excepted. Mr. Brayley Hodgetts had mentioned Count Witte. He had had the honour of commencing his service under Count Witte. Count Witte had committed many faults—as who had not?—but it was necessary to bear in mind the difficulties under which he laboured and also the enormous work he achieved. It was all a question of what class was going to rule Russia. The bureaucracy in the past was bad because the ruling class, of which it was only an instrument, was too remote from the domain of economics, but he hoped that the new ruling class that would arise would be more in touch with the real necessities of modern life and bring about the great economic regeneration which they expected.

The meeting then terminated.

TRINIDAD LAKE ASPHALT.

The famous asphalt lake in Trinidad has always presented great difficulties in efforts to ascertain its depth through boring operations, as the constant movement of the asphalt tends to break, or render crooked, pipes or boring appliances driven into the lake at any considerable depth. Some borings, however, recently made under the direction of the chief geologist of the New Trinidad Lake Asphalt Co., which has the concession from the Trinidad Government for mining asphalt from the lake, have reached a depth of 150 ft., the lowest depth yet obtained. The previous record was 135 ft., reached in 1893. On both occasions the asphalt was found to have the same uniform character as in borings higher up and in other parts of the lake.

The record borings made in 1893 were accomplished by driving down a 2-in. pipe and washing the material out of the pipe by means of a jet with a steel bit on the bottom of it. At the depth of 135 ft. the pipe became so crooked, owing to the movement of the asphalt, that further progress was impossible.

In the borings which have recently been made, writes the United States Consul in Trinidad, a core of asphalt was taken by driving a small pipe into the pitch, and then withdrawing it with its contained core of pitch. Following this, a pipe of 2-in. diameter was driven to the lowest depth to which the core was taken, and the material, forced into it by driving, was removed by means of a water jet and bit. Another core was taken below the 2-in. pipe in the untouched pipe. The deepest of these borings was taken at the centre of the pitch lake, and the asphalt was found to be of uniform character throughout. After completion, this hole was observed to have shifted at the surface 25 ft. in six weeks; a survey showed the movement to exist as deep as 100 ft., and there was a suggestion that the direction was reversed at a depth of between 25 ft. and 50 ft. The other borings, not at the centre of the lake, shifted to a lesser extent. The movement of the asphalt seems to be similar in many respects to the ascending and descending currents in a kettle of boiling water.

The asphalt lake of Trinidad is situated at Brighton, 12 miles west of San Fernando, 27 miles south of Port-of-Spain, and about half a mile from the Gulf of Paria. The lake itself is a flat area of approximately 120 acres, forming a basin surrounded by a low hill.

The original elevation of the lake surface was 137½ ft. above sea-level, but mining operations had lowered this elevation to about 130 ft. in 1918. The asphalt is dug by hand, by labourers using a mattock which, at each stroke, lifts the asphalt out in single chunks weighing usually 60 lb. The labourers carry these large blocks upon their heads to the cars in which they are hauled away.

Crude asphalt as it occurs in the lake is of a very uniform composition, as has been determined by a large number of analyses. The composition is approximately 30 per cent. moisture, 60 per cent. asphalt in a very intimate, uniform emulsion, in which a large portion of the material is in a colloidal condition, and a small amount of mineral matter. During the process of heating or drying the moisture is removed by evaporation, but the mineral matter and asphalt remain in their same uniform proportions, which is one of the important properties peculiar to the Trinidad Lake asphalt, and not common to other mechanical mixtures of asphalt and mineral matter. In appearance asphalt, when dried, changes from a dull, black, spongy substance, to a hard, brittle, jet black, shiny product. Animals or wagons could pass across the lake if they would continue moving, but any weight allowed to remain quiet upon the surface will sink.

From the lake there are two systems of tramway. One is operated by an endless cable, which takes the cars to a terminal station, where the buckets of asphalt are transferred to an overhead cable tramway, conveyed to the loading jetty, a distance of nearly a mile, there dumped into the holds of steamers, and shipped to foreign markets as crude Trinidad Lake asphalt. The second system carries the asphalt in cars of approximately one ton capacity up an incline to the drying plant, where they dump direct into drying stills. In these the moisture is driven off by means of steam coils, and after two days' heating the asphalt is drawn off in a molten condition from the bottom of the drying stills, poured into barrels, and placed in the storage shed until ready for shipment. Then the barrels are rolled from the shed to carriers on the overhead tramway, conveyed to the loading jetty, and lowered into the hold of the steamer.

The holes dug in mining the asphalt soon fill to the same level as the rest of the lake, thus enabling digging to be repeatedly done in the same places. The lake is in constant, but slow and powerful, movement, and material left upon the surface frequently shifts its position and finally subsides. Over the surface of the lake there are a number of peculiar **V**-shaped crevices, very sharp at the bottom, with convex side slopes, apparently places where the asphalt descends from either side. To balance this descending movement, there are small raised places from 1 in. to 4 in. higher than the average flat surface, at which the ascending movement probably occurs.

In many parts of the lake, particularly near the centre, a gas containing hydrogen sulphide is given off in noticeable quantities, and any brass material left near the centre of the lake is tarnished in less than a day. The gas is similar to that obtained in the oil wells within sight of the lake. During the dry season the water which is in the pools near the centre of the lake, and which has not been diluted by rain, is slightly mineralised, indicating a possible origin below the surface. The quantity is small, and during the dry season becomes practically negligible. During the rainy season a great deal of water flows into the basin of the pitch lake, and after a succession of hard rains it is completely covered with water, which is pumped off, however, by means of electric centrifugal pumps.

At the centre of the pitch lake there is an area of soft, black, sticky, viscous asphalt, approximately 50 ft. wide.

In various portions, scattered about the surface of the lakes, are "islands," often 300 ft. long, on which trees are growing. When removed to facilitate mining operations these "islands" appear to consist principally of a thin layer of decayed vegetation and soil, the bottom of the layer being of various depths, very much creased, and seldom extending deeper than 3 ft.

Throughout the area east, north, and west of the pitch lake, and extending to the sea, which is less than a mile distant, are many small areas or patches of asphalt of variable composition, consistency, and appearance; these are the source of what is called "Trinidad Lake asphalt." Shipments of this substance have been made at various times, but the quantity shipped is very small, and it has been almost nothing since 1910.

At Guanoco, State of Sucre, Venezuela, there is another asphalt lake, known as the Bermudez Lake, from which large shipments have been made, almost entirely to the United States. This lake is of a different character, and the asphalt is quite unlike that from the Trinidad Lake.

GENERAL NOTES.

THE MINERAL RESOURCES OF THE EMPIRE.—The Mineral Resources Committee of the Imperial Institute has arranged for the issue of a series of monographs on the mineral resources of the Empire, of which one on zinc ores has already appeared. Others on manganese ores and tin ores are now published by Mr. John Murray. The monograph on manganese ores has been prepared under the direction of the Committee by A. H. Curtis, B.A., F.G.S., and that on tin ores by G. M. Davies, M.Sc., F.G.S., of the staff of the Imperial Institute. In each case the book is arranged in three chapters. The first gives a brief survey of the occurrences of the ores and of the characters and uses of the metals. The second chapter deals fully with the sources of supply within the Empire and the third describes shortly the deposits in foreign countries. The

monographs conclude with a bibliography of the principal publications on the subjects dealt with. The monographs are published at 3*s*. 6*d*. net. Owing to its extensive employment in the manufacture of iron and steel, manganese was in great demand during the war. Unfortunately there was a serious shortage of manganese ores, as supplies from the Caucasus, the chief producer, were cut off, and shipping difficulties restricted the amount available from India, which ranked second only to Russia as a producer of manganese ores. At the present time the output from India is increasing and Brazil has enormously enlarged its production, but in view of the disturbed conditions still prevailing in Russia, there is likely to be a continued shortage of the ore there for some time to come, particularly of the higher grades now required by metallurgists and in chemical industries. Several additional sources are indicated as possible contributors to the world's supply in the future. The Empire is favourably situated as regards supplies of tin ore, and at the present time between 50 and 60 per cent. of the world's output is obtained from British countries. Moreover it holds a controlling influence in the industry of tin smelting and refining. The Federated Malay States is the most important tin-producing area in the world and most of its output, together with ore from Siam, the Dutch East Indies, South Africa, and other countries, is smelted in the Straits Settlements. Bolivia and the Dutch East Indies are the chief foreign producers of tin ore. Owing to the war the German tin-smelting industry has practically ceased, and another result of the war has been the establishment of a tin-smelting industry in the United States, which country consumes 40 per cent. or more of the world's output of tin. Among British sources of supply of tin in the future Nigeria is specially referred to.

THE CHADWICK TRUST AND NAVAL AND MILITARY SANITATION.—The Chadwick Trustees have resolved, under the powers conferred upon them by the scheme which they administer, to award, in the year 1920, a Chadwick Gold Medal and a prize of £100 to the naval and military medical officer respectively in the British service who during the past five years of war shall be deemed to have distinguished himself the most in promoting the health of the men in the Navy and Army. The nomination to the Trustees for such presentation will, as provided by the Trust, be made by the Directors-General of the Naval and Military Medical Services respectively.

NEWFOUNDLAND IRON MINES.—The enormous demand for iron during the war gave a new impetus to the mining industry of Newfoundland. Some of the mines at Bill Island are among the most remarkable in the world, says *United Empire*. There are two areas, both rich in iron ore, one of which has an annual output of 700,000 tons, and is credited with a supply which should be sufficient to last at this rate for nearly 850 years; while the other, with an annual output of 600,000 tons, is believed to contain enough ore to last for about 3,300 years. Newfoundland may therefore be regarded as having an almost inexhaustible supply of iron. The mines are conveniently situated near the coast, where ships of 7,000 tons can be loaded in six or seven hours. The iron is then sent to Nova Scotia for smelting and refining processes.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

JANUARY 21.—ALFRED H. POWELL, "Ancient Cottages and Modern Requirements." The Right Hon. EARL FERRERS will preside.

JANUARY 28.—SIR CECIL HERTSLET, late H.B.M. Consul-General for Belgium, "The Ruin and Restoration of Belgium." EMILE CAMMAERTS will preside.

FEBRUARY 4.—ALFRED E. HAYES, General Secretary, English Language Union, "The English Language and International Trade."

FEBRUARY 11.—LIEUT.-COMMANDER NORMAN WILKINSON, R.N.V.R., O.B.E., R.O.I., R.I., "Naval Camouflage."

FEBRUARY 18.—SIDNEY PRESTON, C.I.E., "English Canals and Inland Waterways."

FEBRUARY 25.—JAMES CURRIE, C.M.G., Ministry of Labour (Training Department), late Principal, Gordon Memorial College, Khartoum, "Industrial Training."

MARCH 3.—WILLIAM JAMES GARNETT, First Secretary, H.B.M. Diplomatic Service, "Mongolia from the Commercial Point of View."

MARCH 10.—H. M. THORNTON, "Gas in relation to Industry and Housing."

Dates to be hereafter announced :—

AIR-COMMODORE EDWARD MAITLAND, C.M.G., D.S.O., "The Commercial Future of Airships."

BRIGADIER-GENERAL SIR HENRY P. MAYBURY, K.C.M.G., C.B., M.Inst.C.E., "Road Transport."

CHARLES H. SHERRILL, "Stained Glass."

LADY INGLEFIELD, President, Buckinghamshire Lace Association (North Bucks and Bedfordshire), "The Hand-made Lace Industry."

GRAILY HEWITT, "Rolls of Honour."

CHARLES CROWTHER, "The Arts and Crafts of Japan" (with examples from the author's private collection).

WILLIAM CRAMP, D.Sc., M.I.E.E., "Pneumatic Conveying Plants, with special reference to the Transport of Grain."

L. GASTER, "Industrial Lighting in its relation to Efficiency."

BRIGADIER-GENERAL LORD MONTAGU OF BEAULIEU, C.S.I., "Roads and Transport in India."

SIR GEORGE CUNNINGHAM BUCHANAN, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

SIR JOHN HUBERT MARSHALL, C.I.E., M.A., Litt.D., F.S.A., Director-General of Archæology in India, "Recent Archæological Discoveries in India."

SIR VALENTINE CHIROL, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

SIR FRANCIS WATTS, K.C.M.G., D.Sc., Imperial Commissioner of Agriculture for the West Indies, "Tropical Departments of Agriculture, with special reference to the West Indies." LIEUT.-COLONEL SIR DAVID PRAIN, C.M.G., C.I.E., LL.D., F.R.S., Director of the Royal Botanic Gardens, Kew, will preside.

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m:—

February 19, March 18, April 15, May 20.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

February 3, March 2, May 4.

CANTOR LECTURES.

Monday evenings, at 8 p.m.:—

CAPTAIN H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S., Fellow of Downing College, Cambridge, and formerly of the Royal Air Force, "Aircraft Photography in War and Peace." Three Lectures.

January 19, 26, February 2.

CHARLES FREDERICK CROSS, B.Sc., F.R.S., F.C.S., "Recent Research in Cellulose Industry." Three Lectures.

February 16, 23, March 1.

WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758-1837." Three Lectures.

May 3, 10, 17.

JUVENILE LECTURES.

Wednesday afternoons, at 3 p.m.:—

LOUGHNAN PENDRED, M.I.Mech.E., Editor of *The Engineer*, "Railways and Engines."

January 7, 14.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 5...Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m.

Geographical Society, 135, New Bond-street, W., 8.30 p.m. Professor J. W. Gregory, "The African Rift Valleys."

Colonial Institute, Central Hall, Westminster, S.W., 3 p.m. (Juvenile Lecture.) Mr. W. H. Garrison, "Volcanoes and the Fire Belt."

TUESDAY, JANUARY 6...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Professor W. H. Bragg, "The World of Sound. Lecture IV.—Sounds of the Town."

Colonial Institute, Central Hall, Westminster, S.W., 3 p.m. (Juvenile Lecture.) Mrs. J. W. Henshaw, "A Story of the Pacific Coast."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Dr. G. H. Rodman, "The X-Rays approached from a Popular Standpoint."

WEDNESDAY, JANUARY 7.—ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 3 p.m. (Juvenile Lecture.) Mr. L. Pendred, "Railways and Engines." (Lecture I.)

Automobile Engineers, Institution of, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. Mr. D. J. Smith, "Producer Gas for Motor Vehicles."

Geological Society, Burlington House, W., 5.30 p.m. 1. Mr. S. S. Buckman, "Jurassic Chronology: I. Lias.—Supplement I. West England Strata." 2. Mr. F. J. North, "On *Syringothyris* Winchell and certain Carboniferous Brachiopoda referred to *Spiriferina*."

Sanitary Engineers, Institution of, Caxton Hall, Westminster, S.W., 7.30 p.m. Presidential Address.

THURSDAY, JANUARY 8...Aeronautical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 3 p.m. (Juvenile Lecture.) Major H. E. Wimperis, "How Airmen find their Way."

Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Professor W. H. Bragg, "The World of Sound. Lecture V.—Sounds of the Sea."

Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Mr. J. Shepherd, "Failures of Turbo-Generators and Suggestions for Improvements."

Historical Society, 22, Russell-square, W.C., 5 p.m. Miss M. Wretts-Smith, "The English in Russia in the 16th Century."

FRIDAY, JANUARY 9...London Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. R. Unwin, "A Few Thoughts on the Development of London."

Malacological Society, at the Linnean Society, Burlington House, W., 6 p.m. 1. Dr. S. Stillman Berry, "On a new species of *Mitra* from California." 2. Dr. A. E. Boycott, "On local variation in size of *Clausilia bidentata* and *Ena obscura*." 3. Mr. H. C. Fulton, "Molluscan Notes, No. IV."

Astronomical Society, Burlington House, W., 5 p.m.

Philological Society, University College, W.C., 8 p.m. Dr. W. Perrett, "The Perception of Sound."

Marine Engineers, Institute of, The Minories, Tower-hill, E., 6.30 p.m. Mr. J. H. Williams, "Oil from Well to Consumer."

Auctioneers and Estate Agents' Institute, 34, Russell-square, W.C., 7.45 p.m. Mr. F. W. Hunt, "Some Aspects of the Housing Problem."

SATURDAY, JANUARY 10...Royal Institution, Albemarle-street, W., 3 p.m. (Juvenile Lecture.) Professor W. H. Bragg, "The World of Sound. Lecture VI.—Sound in War.

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FRIDAY, JANUARY 9, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

WEDNESDAY, JANUARY 14th, at 3 p.m. (Juvenile Lecture.) Mr. LOUGHNAN PENDRED, M.I.Mech.E., Editor of *The Engineer*, "Railways and Engines." (Lecture II.)

INDIAN SECTION.

Friday afternoon, January 2nd, 1920; SIR HARVEY ADAMSON, K.C.S.I., M.A., LL.D., Lieutenant-Governor of Burma, 1910-15, in the chair. A paper on "Burmese Village Industries: their Present State and Possible Development," was read by Mr. A. P. MORRIS, B.Sc., A.M.Inst.C.E., Provincial Art Officer, Burma.

The paper and discussion will be published in a subsequent number of the *Journal.*

JUVENILE LECTURE.

On Wednesday afternoon, January 7th, SIR HENRY TRUEMAN WOOD, Chairman of the Council, in the chair, Mr. LOUGHNAN PENDRED, M.I.Mech.E., Editor of *The Engineer*, delivered the first of his course of Juvenile Lectures on "Railways and Engines."

The lecture opened with a brief reference to the fact that railways are barely one hundred years old, that the earliest railways were run in connection with collieries, and that the first "real" railway, the Stockton and Darlington, was not opened till 1825—only ninety-five years ago. Many of the earliest railways were made with wooden rails and the wagons were drawn by horses or pulled by ropes. The use of the Dandy Cart, in which the horse rode down hill, was then described, and illustrations of a dandy cart were shown on the screen. The audience was then introduced to Stephenson and Trevithick, and after a few words about them the action of steam in a cylinder was explained by means of a mechanical lantern-slide.

The difficult question of adhesion was then discussed, a simple explanation being drawn from the varying adhesion of a donkey pulling a governess cart. Because the early engineers did not know that a smooth wheel had sufficient friction with a smooth rail they used various devices to get enough pull. Blenkinsop's 1813 rack locomotive was illustrated, and its modern descendant, a mountain rack-railway locomotive, was shown.

A model of Murdock's road locomotive was then explained, and a model of Brunton's curious engine that was propelled by a pair of legs was shown in action.

As early as 1803 Trevithick had nearly found the solution, and his engine of that date was illustrated; but Hedley's "Puffing Billy" marked the real adoption of smooth wheels on smooth rails.

The increase of adhesion by coupling wheels was then touched upon, and the progress of locomotives was shown by pictures of Locomotive No. 1 of 1825, and the Royal George of 1827.

These engines brought the history to a very important period. The railway between Manchester and Liverpool was drawing towards completion, but how the trains were to be hauled had not been settled. The directors therefore decided to hold trials at Rainhill, near Liverpool, for a prize of £500. The engines entered for the trial (1829) were then illustrated and described, the slides including a drawing of Brandreth's cyclopede which was driven by a horse walking on a moving platform, which formed the bottom of the "locomotive."

The lecture concluded with a few illustrations of funny funnels and a slide showing an old Bury engine beside a big modern engine, and it was pointed out that the height to the top of the chimney from the rail was practically the same in both engines.

In the second lecture some account will be

given of coaches and wagons and modern locomotives. Signalling will be explained, and apparatus and models will be shown in action, and the lecture will conclude with instructions how to drive a locomotive.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, December 18th, 1919; SIR WILLIAM DUKE, G.C.I.E., K.C.S.I., Chairman of the Indian Section, in the chair.

THE SECRETARY of the Section announced that Lord Meston, who was to have taken the chair, had been detained at the House of Lords by the third reading of the Government of India Bill, and that Sir William Duke, Chairman of the Indian Section, had consented at short notice to preside. A letter had been received from Lord Meston containing an important suggestion as to the future of Indian education, which he proposed to read before the discussion commenced. Sir Michael Sadler, Chairman of the Calcutta University Commission, had also written regretting his inability to attend. He wrote: "I am exceedingly sorry that a University meeting at Leeds prevents me from coming to hear the paper by Mr. Hartog. Great Britain and India are both under great obligations to him for his educational writings and insight. His influence upon the teaching of English has been a boon to both countries, and will grow. Every member of the Calcutta University Commission took an active part in the preparation of our report, but they would all join me in expressing our gratitude to Mr. Hartog for his valuable services in that direction." He was sure the audience would wish him to offer their sincere congratulations to Sir William Duke on his first public appearance since his appointment as Permanent Under-Secretary of State for India.

THE CHAIRMAN (Sir William Duke), in introducing Mr. Hartog, said that the condition of education in India had long been a source of grave anxiety. The large middle-class element was avid of education, and received it in enormous numbers, but the soundness of the teaching, both as a means of development in spiritual matters and as a method of approaching everyday problems, was open to considerable doubt. On the other hand, a vast mass of the population was scarcely touched by education so far as reading and writing were concerned; they were illiterate. With regard to university education, an enormous rush for degrees was accompanied by widespread dissatisfaction with those degrees as denoting a particular stage in knowledge and mental development. To deal with one of the most outstanding of those difficulties, the Secretary of State some years ago sent out the strongest Commission he could get together to inquire into and report on the difficulties which faced the University of Calcutta, and to suggest any improvements that could be made. Sir Michael Sadler was Chairman of that Commission, and Mr. Hartog one of the members. The labours of the Commissioners had extended over eighteen months, and they had prepared a most exhaustive report, which had recently been published. Mr. Hartog was, therefore, able to speak with the fullest authority, owing to his close and recent study of the subject on the spot.

The paper read was—

SOME PROBLEMS OF INDIAN EDUCATION.

By P. J. HARTOG, C.I.E., M.A.

1. A charming French lady whom I once knew said she disliked going to Chamonix because she felt so small by the side of Mont Blanc. I think we may most of us feel at first the same kind of awe and hesitation in approaching the great problems of India, all of them on a scale to which we are little accustomed in our home affairs. And yet, for reasons of a fundamental kind, the problems of India, complex and difficult as they are, have not proved unmanageable in the past. I do not believe that they will be unmanageable in the future. In spite of the fierce dislocations of history, in spite of troubles that have saddened us all, India, with its 315,000,000 of people, leads, on the whole, a peaceful, ordered, and civilised life. Yet India is moving—slowly, but, nevertheless—like the Ganges when it begins to change its course. What is the origin of this change? we may ask. How, if at all, shall we control it? To both questions many would give the same answer—Education; some, Indians and British alike, shaking their heads, and blaming the English for the introduction of disturbing Western ideas; others, Indians and British alike, rejoicing at the liberation of Indian thought from a tyrannous tradition. I have put these extreme views without sharing either. I want, if I can, to try to place the question in a truer perspective.

2. I might well hesitate to attempt such a task if I had to rely on myself alone. But I had the good fortune, for nearly eighteen months, to be working as a member of the Calcutta University Commission under the wise guidance of Sir Michael Sadler, and with very able colleagues, both Indian and European; to travel some 10,000 or 12,000 miles in India itself; to visit all the greater provinces of British India

and several of the native states; to inspect dozens of colleges and schools; to interview hundreds of witnesses; to read a great mass of carefully classified evidence dealing with the more important questions of Indian secondary and higher education. The Commission have expressed their views in a five-volume Report, which I find the Indian press generally calls "monumental," not always with any desire to flatter its authors. There are monuments of different kinds. But I believe that if the structure that we have built is monumental in size it has been made exceptionally easy of access by an ordered plan and subdivisions and summaries. A distinguished friend of mine, after reading the first volume, decided to take the whole five on a journey round the world; and I hope that no one who wishes to become acquainted with our analysis of existing conditions (based on what I believe to be a really thorough investigation), or with our recommendations, will be deterred by the fact that we run to five octavo volumes of a handy size and in large print.

3. Our reference limited us to secondary and post-secondary education in Bengal, which, with its population of 45,000,000 was sufficient to satisfy the ambitions of any Commission. But many of the problems that we attacked were by their nature All-India problems, for although there are differences between the educational systems and conditions of the various provinces, the resemblances are far greater than the differences; and if I deal largely with the problems of Bengal, with which I am best acquainted, I shall not hesitate to touch on their bearings on India as a whole.

4. At the very outset I want, if I may, to distinguish education from literacy; we shall come to the figures of literacy in a moment. But it is essential to remember that India, with its hundreds of millions of people of varied races and religions, is, as a whole, "educated" up to a point. Its populations are under the intellectual sway of complex traditions—literary and religious—developed by past generations of religious teachers, poets, and thinkers and scholars; its agriculture, which is the main material support of the country, is, if not "scientific" in the modern sense, at any rate, by the witness of those who know it best, a fine art; and it has other complex native industries. India forms a great society, or, rather, complex of societies. To regard as "educated" only those who can read and write is to ignore fundamental facts. Literacy, in the East, as in the West, may mean the reverse of education. If I hereafter use the words "education" and "educated" in their more conventional sense, you will not misunderstand me.

5. We now come to the figures of literacy and of education, primary, secondary, and higher; they are striking enough. I take them from Mr. H. Sharp's admirable Quinquennial Review of the Progress of Education in India, 1912–1917, which is itself based on census and provincial returns. Of the total population, only 5·9 per cent. are literate in the sense of being able to write a letter in any single language to a friend and to read his reply. Of the male population of India, only 10·6 per cent. are literate; only 5·31 per cent. are under instruction of any sort. Of the female population, only 1 per cent. are literate, and only 1·03 per cent. under instruction. Roughly speaking, you may say that for the great masses of population the culture of India is only oral and manual, not written.

6. Corresponding to this is the small percentage of the population enrolled in elementary schools, relatively to the figures for other countries. I quote these figures from Mr Sharp:—

	Percentage of the population enrolled in Elementary Schools.
United States	19·87
England and Wales	16·52
German Empire	16·30
France	13·90
Japan	13·07
Ceylon	8·94
Roumania	8·21
Russia	3·77
Brazil	2·61
India	2·38

The analogy of India to pre-war Russia in this respect is worth consideration.

7. When we come to secondary education, the figures are very different:—

	Percentage of the population enrolled in Secondary Schools.
United States of America	1·502
German Empire	0·988
England and Wales	0·62
India	0·486
Japan	0·354
France	0·32

The figures reveal themselves as still more significant when we find that they mean that of the *male* population of India nearly ·869 per cent. (or about 9 per 1,000) are enrolled in secondary schools, the percentage of the female

population so enrolled being only one-tenth of that number, or less than 1 per 1,000. It is true, on the other hand, that these figures include the pupils of secondary schools who are enrolled in their primary classes, and amount to nearly half the whole number. Even when these allowances are made, the contrast between the figures for primary and for secondary education is very great. You have in India an illiterate peasantry and industrial population, literate middle classes.

8. We now come to university education. The figures are comparable to those for secondary education. The following approximate figures are given by Mr. Sharp for 1914–15; they are undoubtedly liable to correction, but are sufficient to indicate the facts :—

	Percentage of population enrolled in Universities.
United States	0·218
France	0·106
Italy	0·063
Netherlands	0·066
England and Wales	0·054
India	0·024

Of the Indian *male* population the percentage receiving university education is 0·048, or, say, 5 in 10,000, not far short of the British figure for the population as a whole. If we take Bengal we find that in the University of Calcutta, which has some twenty-five of its colleges in Calcutta itself, and rather more than this number scattered through the province, there were in 1917–18 just under 26,000 students, as against the 26,700 "full-time" students in all the British universities together, in the year before the war.* The full-time students in the British universities included many who were not preparing for degrees. In Bengal all students are preparing for degrees.

9. The epithet commonly applied to Indian education is "top-heavy," and some have proposed to bring it to a stable condition by diminishing the apex of the pyramid. Our Commission believed it to be a sounder policy to extend the base. Policy, as Lord Cromer pointed out, invariably means finance, and the financial aspect of the problem is not easy. Can India—"a poor country"—afford proper education? We ask, rather: Can India, being a poor country (if it is a poor country), afford not to have it? Does not education—in the true sense, as distinguished from literacy—conmote a greater control of natural resources, which will compel from Nature a greater yield to support her population, as well as a richer moral, artistic, and intellectual life? I cannot here go into details of Indian finance, and should hesitate to do so in the presence of some whom I see here to-day; but I have been authoritatively assured that Bengal can raise much more than she now does for this, the most productive form of expenditure. The late Major J. C. Jack, whose death in the war was so great a loss to Bengal, declared, in his book on "The Economic Life of a Bengal District," that local taxation in the Presidency amounts to only about ½ per cent. of the total income of the population, and contrasted the taxation for local purposes in Bengal with that in Italy, a poor European country, which is many times as great.

It will be for the local Governments under the new *régime* to show whether the enthusiasm for education professed by so many is a real enthusiasm, willing to make sacrifices. The London ratepayer cheerfully pays an amount equal to about 10 per cent. of his rent for educational purposes; and in a vast number of cases he pays this for the education of other people's children, as he sends his own to schools not assisted by the rates. I confess that I have been disappointed to find among some Indian friends an enthusiasm for education singularly unwilling to face the clear fact that to become effective it must translate itself into a readiness to be taxed for the purpose — that it must bear the test of genuineness to which all Western nations have submitted.

10. I have said that expenditure on education would be productive expenditure. But the serious question arises as to how far it is productive in the best sense at present, and what changes are needed to make it more productive. That was the problem which our Commission had to consider. Let us briefly sketch the Indian system as it exists to-day. In the broad outlines of its organisation it does not differ very largely from European systems. It includes primary schools, secondary schools, and universities with colleges, and parallel with these a series of institutions for technical education—primary, secondary and higher. All educational institutions are officially divided into "public institutions" and "private institutions," according as they provide or do not provide a course of study recognised by Government or a university; and the public institutions may be either "publicly managed" *i.e.* directly managed by Government or by a local board or municipality, or privately

* See *Nature* for August 15th, 1918, p. 474.

managed. The privately managed institutions may again be "aided" by grants from public funds or "unaided."

11. Of the primary schools, only a few are managed by Government (1,353), a larger number are managed by local bodies (39,172), and many more are private schools (101,678, of which 85,353 are aided and 16,325 are unaided). The great majority of the primary schools are vernacular; out of 5,818,730 pupils of both sexes in primary schools, only 92,000 learn English.

12. When we come to secondary schools the question whether they teach or do not teach English (a matter on which I shall have more to say later) is an important feature in their nomenclature; they are described as "anglo-vernacular" or "vernacular." But I pass on to their general structure.

Many secondary schools contain primary classes. All "complete" secondary schools are divided, for the sake of convenience, into a "middle stage," generally of four years (but in some provinces of two or three), and a "high" stage, also varying from two to four years in different provinces. The characteristic of the "high stage" is that it prepares for a matriculation or school-leaving examination; and the highest classes in the high stage are conducted, or are supposed to be conducted, entirely through the medium of English (except in Burma, where there are a few vernacular high schools). The "complete" secondary school, with a curriculum of ten years, is supposed to take a boy up to the minimum age of matriculation, which is sixteen in the University of Calcutta and most other Indian universities. As a matter of fact, the average age of matriculation candidates presenting themselves from secondary schools in Bengal was eighteen years four months in 1918, and it is by no means uncommon to see young men of nineteen, twenty, and even twenty-one, in the high schools, a state of things which should be changed, though it can only be changed gradually.

There were in British India, in the quinquennium 1912-17, 7,693 secondary schools with a population of 1,186,335, of which 2,756, or over one-third, were in Bengal, as against 449 in Madras, 465 in Bombay, 761 in the United Provinces, and 1,400 in Burma.

13. Following on the high school comes the university course of four years for a bachelor's degree in Arts, Science, or Engineering, divided by the intermediate examination into two periods of two years. This leads on to another two years' course for the M.A. or the M.Sc., and a three years' course for the over-popular B.L. degree, which is a post-graduate degree, and is often taken concurrently with the M.A. degree. With a few exceptions university classes are conducted entirely in English.

14. There were in the quinquennium 1912-1917 five universities in India (Calcutta, Bombay, Madras, Punjab, Allahabad), to which have been recently added a new university at Patna, the new Hindu University at Benares, the new university in the native State of Mysore, and the Osmania University in the native state of Hyderabad. Others are in contemplation, notably at Dacca, Rangoon, Aligarh, Lucknow, Agra, Nagpur, and in Baroda.

During the quinquennium the five universities had 184 colleges, of which 28 were in the Native States and 57 (or not far short of a third) were attached to the University of Calcutta.* University teaching has been mainly given, up to the present, in colleges, though there are notable exceptions—especially in Calcutta and at Allahabad, in both of which universities important teaching is given directly under the university authority.†

One remarkable feature in university statistics is the high proportion of students pursuing purely literary courses—in the University of Calcutta over 22,000 out of 26,000.

15. Many Indian writers regard the development of the industrial and technical schools and colleges as the most urgent need of India.‡ But to deal even briefly with these special schools, or to do more than mention the special problems of women's education, and of the education of Musulmans and of Europeans, all full of interest and difficulty, would carry me beyond the limits of this paper.

16. Having taken this general survey of the external structure of the educational system, I wish to draw attention to five factors which affect that structure throughout, and give rise to important differences between education as we know it in Great Britain and education

* This number was slightly reduced by the creation of the University of Patna. The number of colleges in Bengal still exceeds fifty.

† The colleges are divided into "arts colleges" (in which the ordinary curriculum in science as well as in arts, leading up to a B.A. or B.Sc. degree, is given), law colleges, medical colleges, engineering colleges, and agricultural colleges.

‡ The subject of higher technical education in Bengal is discussed in the report of the Calcutta University Commission. The subject of Indian technical education in relation to the development of industries is dealt with in the report of Sir Thomas Holland's Indian Industrial Commission (1916-1918); and reference should also be made to Mr Sharp's Quinquennial Review, quoted above, especially to paragraph 13 and Chapters XI. and XII.

in India: (1) caste; (2) the seclusion of women; (3) the pay and social position of the teachers; (4) the medium of instruction; and (5) the influence of examinations.

17. Caste, which I have mentioned first as contributing the most striking of factors unfamiliar to the West, seemed to me to have surprisingly little influence in Bengal, except in one direction. Students of all castes mix freely on the benches of schools and colleges, though they do not eat together.* I am told that in some cases it is difficult for the lower castes to gain admission to school or college, but of this I saw no direct evidence. But on technical instruction, caste has an immediate influence. It is the tradition of the higher castes to despise manual labour, and though the prejudice is going, it will for many years deprive the schools of engineering, technology, and agriculture, of some who might have been their most gifted students.

18. It is perhaps hardly accurate to call the *purdah* system a factor in Indian education. On the contrary, it means, speaking broadly, that the vast majority of Indian women and girls, above the age of childhood, are excluded entirely from the educational system. In the universities, such women as are willing to attend have long been admitted to all privileges on equal terms with men.† Women students are still insignificant in numbers; but possibly the influence of women graduates may, combined with political changes, inspire *purdah* women with a desire to receive an education comparable with that of their men-folk.

19. I come to the pay and social position of teachers. The average monthly pay of the primary teacher is Rs. 9·2 (even at the present high rate of exchange under £12 a year)—often less —a pittance that would hardly satisfy a labourer. Of course, in comparing salaries with European salaries, we must bear in mind that, owing partly to climate, partly to custom, most Indians live a far simpler life than Europeans; their needs are less. Again, in many primary schools, *pathsalas* for the Hindus and *maktabs* for the Musulmans, the teaching is almost solely religious, confined to the teaching of religious texts, and given by a holy man who lives mainly on alms, thus conforming more closely to the old Indian ideal of the teacher—an ideal, I fear, that is bound to disappear largely with the increased claims of secular education.

In the secondary schools there is a far greater range of salaries; they appear to go as low as Rs. 4–5 a month, and up to Rs.400 (£520 a year at the present rate). From Rs. 25 to Rs. 50 a month is a common commencing salary. In Government and some other schools the posts are pensionable.

The average salaries of teachers (excluding principals) in the Bengal "arts colleges" in 1917 (I have not the figures for British India) were Rs. 256 a month in the Government arts colleges, rather less than half that for the private colleges. In the Government colleges, at any rate, and especially in the Presidency and Dacca colleges, the average pay would compare not unfavourably with the pre-war average of a modern English, French, or German university. In the private colleges, and especially in the case of teachers of Sanskrit, there is a marked difference, and many of the salaries are painfully inadequate. But there is, perhaps, no such general discrepancy between the Indian and British rates of payment to university teachers as exists in the case of primary and secondary teachers. Life in Calcutta is of course dear; but outside Calcutta the Indian university teacher in Bengal before the war was probably as well off as an English university teacher—in many cases better off. We cannot compare present Indian conditions with those in England, which are now being reconsidered, and which will have to be considerably modified if university teachers in this country are not to suffer serious depression in the social scale.

20. I now come to the vexed question of the medium of instruction—a question of profound importance, on which there prevails, not only remarkable misconception, but a surprising divergence of opinion, a divergence which cuts across every division of race and religion, of political views, and of occupation.*

In order to gain a clear idea of the situation in Bengal, which is in many ways, though not entirely, typical of India as a whole, we must go back rather more than a century. At that time the choice of medium of instruction for secondary and higher teaching did not lie between English and the vernacular; the vernacular was

* I was told in a chemical laboratory in Allahabad (United Provinces) that twenty years ago high-caste students would not have used water distilled by a "sweeper," but that this is no longer the case.

† Mrs. Scharlieb received her early medical training in Madras at a time when it would have been difficult or impossible for a woman to obtain medical training in this country.

* The subject is dealt with more fully in Chapters XVI. and XLI. of the report of the Calcutta University Commission.

regarded by all alike as unfitted to convey such instruction, just as the European vernaculars were so regarded in the Middle Ages. The choice lay between the classical languages of India—Sanskrit for the Hindus, Arabic for the Musulmans—on the one hand, and English on the other. The first educational efforts of the East India Company were devoted to teaching in the classical languages. The Calcutta Madrassah was opened by Warren Hastings in 1781; the Sanskrit College, under Lord Amherst's administration, in 1824. It was by voluntary effort that teaching on Western lines, through the medium of English—still somewhat mis-named in India as "English education"—was started in Bengal. That voluntary effort was of two kinds—missionary effort (which has played, and still plays, so large a part in purely secular Indian education), and the effort of two remarkable men, an enlightened and cultured Brahmin, Raja Ram Mohan Roy, and David Hare, the Calcutta watchmaker, to whose tomb Hindus make an annual pilgrimage on the anniversary of his death. These two men together founded the Hindu College, or Vidyalaya, which was opened in 1817 as the first college for English education, and established mainly by the generosity of Hindus. The taste for English in Bengal became widely disseminated, and it was reported in 1831 that independent schools, conducted by young men trained in the Vidyalaya, were springing up in every direction. It is often asserted with misplaced vehemence that English has been imposed on Bengal; it is not so. English sprang up in Bengal by the sheer desire of the Hindus to learn it, though no doubt that desire was stimulated by the wish to occupy places as clerks in Company employment and business firms. How little compulsion there was in the matter is proved by the fact that the Musulmans, who form the majority (over 52 per cent.) of the existing Presidency of Bengal, for long years stood absolutely aloof from Western education for reasons into which I cannot here enter; and they still form only 20·5 per cent. of the population of the high schools, only 8·8 per cent. of the population in the arts colleges of the university, and only 6·8 per cent. at the professional colleges. The Musulmans are now making great efforts to recover the lost ground.

21. The policy of the British Government was changed by Macaulay's famous Minute of 1835, and the action taken by Lord William Bentinck's Government on his recommendation. By that action the Government diverted to "English education" the funds previously devoted to the encouragement of the learned Eastern tongues. Macaulay's Minute has often been represented as sacrificing the vernaculars to English. As Lord Chelmsford recently pointed out in an address at Simla, this was not the case. Macaulay and the Public Instruction Committee, of which he was chairman, were "deeply sensible of the importance of encouraging the cultivation of the vernacular languages"; and, indeed (I quote from one of their reports), they "conceived the formation of a vernacular literature to be the ultimate aim to which all their efforts must be directed." If we examine the great education Despatch from the Directors of the East India Company of 1854, the Report of the Education Commission of 1882, the Report of the Universities Commission of 1902 instituted by Lord Curzon, and the Government of India's Resolutions of 1904 and 1913, we find that during the whole period since Macaulay's Minute "the policy of Government has been unswerving in its double aim of conveying Western education in its higher forms through the medium of English to the Indian peoples, and of encouraging the development of the vernaculars so as to fit them for every use." *

How far has it succeeded in this aim? Ought there now to be a change of policy? Have the vernaculars now been sufficiently developed to be used as the medium? If not, at what stage ought English to be first used as the medium? These questions have been, and are being, discussed, with passion, in India; and the evidence received in response to the questions of the Commission on this point exceeded in volume, and perhaps in ability, those dealing with any other point. I shall not repeat here the analysis of that evidence. I will only say that while some Indians of more or less advanced political views regard the use of a medium other than the vernacular as "most unnatural, unscientific, and unnecessary, and nowhere followed in any other part of the civilised world," and the "evil of forcing an alien language as serving to dry up at their sources the very fountain springs of national power," others, like Mr. Natarajan, of the *Social Reformer*, thunder against the least attempt to diminish the place of English in Indian education as an attempt to keep India in darkness, and would extend the teaching of English to primary education. The differences of opinion existing among

* Report of the Calcutta University Commission, Vol. II. p. 241. (Chapter on the medium of instruction and examination.)

Indians are found in equally acute forms among Europeans playing an important part in Indian education and Indian administration. The Rev. W. E. S. Holland, then Principal of St. Paul's Cathedral College, Calcutta, wrote: "To be educated in a language which is not the medium of thought must cramp intellectual development in all kinds of ways. The foreignness of our whole curricula sterilises our best Indian minds." But other Europeans of equally high standing think the increased use of the vernacular would be contrary to the best interests of the country. In Bengal, as a whole, the desire for English is not only strong, but increasing.

"The Secondary Vernacular School," says the Director of Public Instruction, "is no longer in demand. A knowledge of English is nowadays regarded as the first necessity of life—the doom of Secondary Vernacular Schools is, in fact, sealed."*

It is only by a great public movement that the current could be turned back.

22. The Commission hope to have found an eirenicon in the policy of bi-lingualism (it is strange how rare the term is in our evidence), a policy adopted by the educated classes in Wales, in large parts of Canada and South Africa in our own dominions, and in other countries like Switzerland and Belgium, which has not in any way, we believe, diminished the intellectual power of the inhabitants. We have come to the conclusion that while the vernacular should be used to an increased extent up to the matriculation stage and as the medium in all subjects except the teaching of English itself and of mathematics, the premature use of a foreign and half-understood medium has tended to produce intellectual muddle more or less concealed at matriculation by remarkable feats of memorisation; and we suggest that at that stage the use of English should be optional, except in the two subjects I have named. Beyond that stage, and especially in the first two years following it, English should be fully mastered, and it should be used exclusively in the highest stage except in teaching Oriental languages. That is the solution we adopt for the moment. In spite of the secular traditions of Bengali literature, in spite of the modern school, headed by the illustrious Tagore, we are convinced by Indian evidence that this vernacular, the most developed of all Indian vernaculars, is still unsuited for the highest teaching in Western subjects. May I quote here our general conclusion?

"We do not wish to prejudge the future. It is not for us to predict whether the natural desire to use Bengali to the utmost will eventually outweigh the immense advantages of being able to use a medium common not only to the educated classes throughout India, but to more peoples than any other, and giving access in effect to the literature and the scientific records of the world. We are disposed to think that the educated classes in India will, like those of some other countries, both in the British dominions and elsewhere, wish to be bi-lingual; to use their mother-tongues for those dear and intimate things which form part of life from infancy upwards, and which are the very breath and substance of poetry and of national feeling; to use English as a means of intercommunication necessary for the maintenance of the unity of India and of touch with other countries; for the mutual interchange and stimulation of ideas in the sphere of scholarship and science; and for the promotion of that inter-provincial and international commerce and industry on which the economic future of India will largely depend."

23. Before leaving the subject of medium entirely I want to touch on one point which concerns India, but not India alone. It is a point that has not been fully realised in Western education—the use of the mother-tongue as a means of mind-training, and especially for the stimulation of individual thought, of individual judgment, of the intellectual conscience of the pupil exercised even as against the teacher. In the greater part of school education the ultimate decision in regard to a piece of work rests, and must rest, with the teacher. There is little scope either for originality or for the exercise of really independent judgment. But if the mother-tongue is used as a means of mind-training, if the pupils are encouraged to write from time to time on subjects within their own experience, of which from their very nature they know not less but more than their teacher, and are encouraged to exercise their own powers of criticism on such work; if they are asked to write on a given subject, with a definite object for a definite audience; if they are then asked (with the help of the teacher and of the class) to criticise their own success or failure, but to be themselves made ultimate arbiters of whether or how far they have succeeded or have failed in their modest task, an entirely new element has been introduced into their education. I quote once more from the Report: "To pupils trained by such methods as we suggest, the printed document loses its magic authority: they have learnt for themselves what sincerity in writing means, and to be alive to the signs of sham and confusion of thought, whether in

* "Progress and Education in Bengal, 1912-13 to 1916-17," by W. W. Hornell, C.I.E. (1918), p. 29.

manuscript or print. In learning to judge the merits and faults of their own productions they have also learnt to judge those of others."

24. I have spoken of stimulating individuality and individual judgment. We now come to the machine which in India, to a far greater extent even than in this country, has tended to crush them out—the examination machine. With this subject (on which I spoke in this hall some years ago) I wish now to deal comparatively briefly. Our Report has, I believe, given a more complete analysis of the problems of an examination system than has been previously attempted. I shall illustrate one of its characteristics, so often and eloquently denounced, by a single example. A distinguished Indian told me that in his early career he had been asked a particular question, and knew that the answer was contained on a particular page of a particular book, but not exactly in which sentence, so he wrote out the whole page from memory; and he added that it was many years before he understood that his grievance against the examiner who ploughed him was not justified.

The survey of existing conditions we have summed up in these words :—

"It is impossible to peruse the evidence on the examination system as it exists to-day in Bengal without a feeling of profound sadness. The immensity of the effort, disproportionate to the results; the painful anxiety of the candidates; the mechanical award of marks encouraging the least fruitful efforts of the mind; a leniency sometimes neglecting the grave responsibility of the university to the public, and tending to class the less with the more deserving candidates; the number of failures in spite of that leniency; the sterilising influence of the whole system on both teachers and taught, and the consequent crying waste of the intelligence of the youth of Bengal—these are evils which have been brought home to us by the most convincing evidence from witnesses of every section of the community, as well as by what we ourselves have seen. These evils can only be eradicated by resolute and determined reform, accompanied by a change in the whole spirit in which the university institutions of Bengal shall be administered in the future." (Report, Vol. II., Chapter XVII., The Examination System, § 184.)

25. We have been criticised by some persons, who regard reform as synonymous with change in regulations, on the ground that our proposals for reform are not sufficiently detailed. We believe that no change in regulations will effect reforms without a profound change in the whole attitude towards examinations.

We have shown that the evils of the examinations arise very largely from their uncertainty of purpose. They are meant as a test. What do they, in fact, test? What can you certainly say of the persons who pass them? We have suggested that their purpose should be formulated in each case; that the design of each examination should be made to correspond to its purpose. From those general principles, if they are applied, the details of examination regulations and their rational interpretation by examiners will flow. To have set up a new hard-and-fast system would have been to replace an old rigidity which has tended to grow meaningless by a new rigidity which would soon become no less meaningless. It is only by asking again and yet again the question "What does an examination mean?" that it can be kept from sclerosis. In order to ensure that such questions shall not be forgotten, we propose new machinery (I hope the word will satisfy our critics), a new Examinations Board, whose business it will be to act as the auditors of the examination system and the wakeful conscience of the university in this matter; not an executive board, but an advisory board, with power to investigate examination results, statistically and in detail, and to publish for the information of the public typical examination answers. Such answers, I suggest, should be neither necessarily the best nor the worst; average answers, and especially border-line answers, just enabling a candidate to pass, are what the educated public and especially the body of university teachers as a whole should see from time to time, in order that the exact significance of a university diploma may be brought home to them. If I remember right, the inspectors of medical examinations appointed by the General Medical Council here give definiteness to their reports by the quotation of such answers as I suggest.

26. I greatly regret to see that the new Dacca University Bill and Statutes do not provide specifically for an Examinations Board of the kind we have recommended. I trust that the omission is only due to an oversight.

27. I have spoken of five factors which differentiate Indian from British education. There is another great factor which influences the number and character of the students who now crowd into the colleges of Bengal. At present, we were told by the Indian headmaster of a high school, "nearly all students who matriculate flock to the university without consideration of their individual bent, or their special talents, or their fitness for university training, or of their future life. . . . The majority of these students

are . . . unfit to receive university training." The ultimate reasons for this rush to the university are no doubt many and complex, but there is one simple fact that accounts for much.

28. At present in India, for the vast majority of Indians, there is only one way to a career, and that lies through the university. The Indian landowner and, in Bengal, the Indian business man, is born rather than made; the commerce of Bengal is mainly in the hands of a Rajput community (the Marwaris) and the Europeans. The varied careers of commerce and industry, for which the passing of an examination is not required, and which lead in Europe to the highest positions in the community and in public life, are only beginning to open out in Bengal.* Broadly speaking, if you wish to make your way by your talents and energy in Bengal, you must go through the university mill, and the way to the university is through the high school, a fact which now seems to be known even to labourers' families throughout the Presidency.

29. Hence an excessive pressure on the high schools and the universities, a pressure increasing daily, of which even the post-war pressure in England scarcely gives us an idea; hence the multiplication, growing daily, of secondary schools, run for private profit, with inadequate and miserably paid staffs, dirty, dingy, overcrowded; hence colleges of the university with inadequate and unused libraries, 1,500 or 1,600 students crowded into a few lecture-rooms, sometimes forced, by want of accommodation, to go into the streets between lectures, receiving instruction of which the be-all and end-all is the passing of the examination. Training indeed, but training that deforms the intelligence and weakens the mental powers of Bengal. If I have described the worst, it must not be taken that this describes the best. Some of the colleges, notably the Presidency College in Calcutta and Dacca College—which are Government colleges—and some others, would in many ways be an ornament to any university, and Calcutta and all the other important university centres in India are now active centres of research. But the serious element in the situation is that while the Government colleges and a few others resist the pressure of numbers, the pressure is growing, and that with the increasing demand for education, unless drastic measures are taken, the education itself will grow not better but worse.

30. Let me give a few figures. From 1912 to 1918 the number of students enrolled in the "arts colleges" in the University of Calcutta increased from 10,980 to 18,478, an increase of 68 per cent. in seven years. During that period the number of pupils in the English-teaching secondary schools of Bengal increased from 260,000 to 378,000, or 40 per cent.

31. We have thus a system feverish, strained, mechanical. To some of our advisors the remedy has seemed as obvious as the facts. "There are too many students in the universities and the high schools for efficiency. Diminish the number." We have regarded that advice as irresponsible advice. You cannot deal with a great popular movement by simple denial in that way. We asked ourselves, instead, at what point could new life be most effectively infused into the whole organisation.

32. It has long been apparent to those concerned with Indian higher education that the work of the first two years in the university was probably its weakest spot. To give instruction through the medium of English to youths of whom a large number cannot understand the spoken language; to lecture to youths whose sole idea of taking notes is to copy down verbatim, and who, even if they do understand English, are so little trained mentally that they are unable to distinguish what is essential in a lecture from what is merely accessory; in a word, to base your methods of instruction on hypotheses which are obviously untrue; this could only lead to failure in teaching and failure in examinations on a large scale, if the examinations were not to be a farce; and both the intermediate examinations themselves and the number of rejections have been serious. It was clear to our predecessors, the Commission of 1902, that the "second-grade colleges," as they are called, which provide only this two years' course, without the additional two years' course, were unsatisfactory. They proposed that they should be abolished. We recommend that they should be improved, separated from the university system, and reconstituted.

33. We thus propose to increase the minimum age for entrance to the university from sixteen to eighteen (or seventeen in exceptional cases), a proposal which, I gather from the Indian newspapers, has been welcomed generally, if not universally, all over India.

But that change implies others, both above and below the level of university entry. I deal

* In Bombay the case is different. There are large Indian firms belonging to the Hindu as well as to the Parsee community.

first with the changes below the university level; for improvement below this level is a necessary antecedent to any really great improvement in the university itself; and those changes must be of two kinds—administrative and educational.

34. We propose that secondary education and the education of the two years to which I have referred, which might be called "higher secondary," but which for the sake of convenience we have called "intermediate education," should be transferred to a new authority—"The Board for Secondary and Intermediate Education" — consisting of from fifteen to eighteen members, of whom seven would be university representatives, one elected by the non-official members of the Legislative Council of Bengal, and the remainder appointed by the Government of Bengal.

Other important points in the constitution are that there should be a salaried chairman; that the Director of Public Instruction should be an *ex-officio* member; that there should be representation both of Hindu and Musulman interests (by not less than three members each), and representation of experience in agriculture, industry and commerce, medicine and public health, teaching in intermediate and secondary schools, the education of girls, and the education of the domiciled community; and finally, that a majority of the board should be non-official, *i.e.*, consist of persons not in receipt of a salary paid directly by the Government.

We should have much preferred a board of from five to seven members, but the diversity of interests and educational needs is too great to be adequately represented by so few.

35. To our Board we should entrust a substantial measure of control over Government secondary and intermediate institutions, the "recognition" for the purposes of matriculation (which we re-name the High School Examination) and of the intermediate examination, of all high schools and intermediate colleges, and the definition of their curricula, the inspection of such schools and colleges, and, subject to budget control, the making of grants to those institutions. Two of our colleagues—including our Musulman colleague—dissented in regard to the last two points.

I believe that important members of the Muslim conmmunity think that in the matter of grants and inspection they would receive more favourable treatment by a Department of Public Instruction than by the Board. I regret that view, as I believe the dual control which they propose would make the business of the Board more difficult to conduct; but this is, after all, a matter which could be adjusted.

36. The Board is only a means to an end—the improvement of this two years' course, on which the efforts for reform can be most effectively concentrated, as well as of secondary education generally. We have suggested that (say) thirty "intermediate colleges" should be provided in Bengal for this purpose—of which some would be the present "second-grade colleges," some would be existing "first-grade colleges," which decided to devote all their energies to this important intermediate work, and others, again, would be attached to existing Government high schools. Thirty such institutions is a manageable number. You cannot in any short time deal with the 700 high schools of Bengal; you can do much to supplement the defects in their teaching by effort in the thirty colleges to which their best students would proceed.

37. The new intermediate college will have a double purpose—(1) to prepare better than heretofore the students who desire to enter the university; (2) to prepare others for various practical careers of a kind for which university training is not needed—many branches and grades of industry, commerce, engineering, and agriculture, primary teaching, and the lower branches of Government service. It is clear that Indian commerce and industry are developing; they may be expected to absorb at an early date a largely increased number of youths with a sound practical education.

38. We propose for these colleges a varied curriculum, and suggest only three subjects as compulsory for all students. First, practical English, to be taught in relatively small classes and by methods far more modern and efficient than the wasteful ones hitherto adopted.* Such teaching should, at any rate for a time, be directly guided by English teachers. Secondly, the vernacular, with better teachers and better methods, not only for its own sake, but as a means to clear thinking. Thirdly, physical training, with good recreative facilities.

For those students who definitely intend entering a university we suggest a choice of four additional subjects, selected from some such list as the following:—(1) a classical language; (2) history; (3) geography; (4) English

* A Bengali boy devotes in the four upper classes of the high school on the average about twelve hours in school and fourteen out of school to learning English, with the average results stated above. There are, of course, many exceptions in the thousands of pupils.

literature; (5) logic; (6) economics; (7) mathematics; (8) physics; (9) chemistry; (10) biology.*

Students destined for arts, science, or medicine would all find the necessary elements in such a course. For an engineering student a higher standard of mathematics and mechanical drawing would have to be added; for agricultural students, land-surveying, an introduction to the principles of agriculture, and some training in book-keeping; for commercial students, commercial geography and accountancy; for teachers, some introduction to the art of education and perhaps some teaching practice.

39. Clearly the intermediate colleges ought to be of different types; and any one ought only to supply a small number of alternative courses, if the numbers are to be kept within the limits necessary for efficiency. The recent dictum of "each one different from the last, each one better than the last," has as much to be said for it in designing colleges as in designing ships, and with this advantage, that, unlike a ship, an obsolete college can be reconstructed instead of being scrapped.

40. It should be an essential part of the intermediate college course that the teaching should be given by school methods as far as possible. It is the give-and-take method of the best schools with daily control of each boy's work that is needed at this stage—not the looser control by the teacher, the greater responsibility of the student of the university. I do not mean to suggest that the Indian boy is idle; in many cases he works far too many hours. I have questioned many boys in many schools and many colleges. It is a common thing for Indian boys of from twelve and thirteen upwards to be at their lessons or books ten hours a day, and to work on Sundays as well as in the week, a practice which is only compensated for by the large number of holidays, both Hindu and Muslim holidays being observed as well as the major English holidays. But much of this work is unsystematic and undirected, or devoted to mumbling aloud passages to be learnt by heart. The buzz in a hostel, when many boys or students carry on this practice simultaneously is a thing not easily forgotten.

A correlative of the proposal that school methods should be adopted is that the pupils should be of school age. The substitution of the vernacular for the English medium in most subjects of the high school course should greatly accelerate progress through that course, and gradually diminish the average age at the "matriculation" stage.

41. One of the great advantages of the new system would be to prevent Calcutta, which already has 15,000 students, from being flooded by youths who need school instruction and discipline; for the majority of the intermediate colleges would be in the *mufassal*.*

42. I now come to the university stage, which, again, requires reform, administrative and educational. I do not want to weary this audience by a detailed description of the constitutions we have recommended for the Universities of Calcutta and of Dacca. Our general aims may be expressed very simply—it is to enlarge their responsibilities and their powers. The provincial Indian universities have been created by acts of the Imperial legislature; the great majority of the supreme governing bodies, or senates (as they are called) are appointed by the Chancellor, who is invariably the head of a Government; the bulk of the funds required for the conduct of their work, in addition to the fees paid by students, is supplied by Government (in Bengal between one-third and one-half of the total cost); the character and equipment of the teaching institutions which prepare students for university examinations are in the main determined by Government.

In the case of Calcutta it is not by the Government of Bengal, but by the Government of India, more than 1,000 miles away, that the University is largely so controlled; the sanction of the Government of India would be required to add an examination paper in English, or Sanskrit, or mathematics at the B.A. examination.

The changes we propose are all in the direction of giving greater autonomy and responsibility to the universities. Entire autonomy was advocated by scarcely any of our witnesses. In a country where racial animosities have existed for so long, all parties feel that Government, which is, on the whole, regarded as impartial as between Hindus and Musulmans, must retain more control than might otherwise be necessary. But at every point we have tried to safeguard Muslim interests by providing for their representation on university boards, and by providing a special advisory board to look after them. Having regard to the backward condition of

* I have not followed here the exact order or text of the Report.

* The name conveniently given in India to the portion of a province or presidency outside its capital.

the Muslim community, every reasonable means must be taken to encourage Muslim students.

43. The constitution which we recommend is somewhat analogous to that of the English provincial universities; we propose a large representative court, with greater control of finance than the corresponding courts of English universities; an executive council; and an academic council, faculties, and boards of studies as committees of those faculties. While the constitution in its fundamental points will be settled by Act as heretofore, and statutes should, as in this country, be only alterable with public sanction, minor alterations of ordinances and regulations may be made by the university itself, though ordinances should be subject to the veto of the Chancellor.

44. We think the system of having in one city a number of isolated and independent colleges, all doing work of exactly or almost exactly the same pattern, is a bad one. For a small city like Dacca we recommend that the teaching should be placed entirely in the hands of the central university authority. In Calcutta, where there are twenty-five colleges (with some of the best of them on a sectarian basis), but where recently nearly all the post-graduate work has been taken over by the university, such an arrangement would be impracticable, and a new kind of synthesis is necessary. The colleges must be brought into closer touch both with each other and with the university bodies, on which they have hitherto had no direct representation.

45. One of the features of university organisation in India is the considerable number of isolated colleges in country towns, the majority with totally inadequate resources, giving university education in name; in reality, preparing only for university examinations. There is perhaps less reason in Bengal for such dissipation of energy than elsewhere. The Bengali boy who, owing to the dispersion of the population in villages rather than in towns, rarely finds a college within reach of his home, is just as ready to travel two hundred miles as twenty; and hence a concentration of resources in a comparatively small number of centres, provided with an adequate variety of teaching, adequate libraries, and adequate laboratories—centres of a kind likely to develop ultimately into universities—would be all to his advantage. Nothing is more depressing in Bengal than to see the uniformity of model and inadequacy of resources of the numerous colleges in the *mufassal*, although many of them contain excellent teachers whose value would be doubled if they could be brought together.

The creation of such potential universities would not, under our plan, leave the districts educationally derelict. We hope that the intermediate colleges may become living centres and develop, by means similar to those of our University Extension movement, some form of adult education, a subject of which the full importance is only just being recognised at home.

46. In the Universities both of Calcutta and of Dacca we propose to set up a new organisation to deal with the education of *purdah* girls and women—a subject that can only be effectively dealt with by the co-operation of women who are themselves *purdah*. We have been criticised both for going so far and for going no further. I think that while we have not underestimated the immeasurable importance or the urgency of the problem, we have done well to stay on the threshold, and only to point to methods by which it may be solved. As I have said above, Indian universities have long been open to the small number of women willing to attend them.*

47. So much for administration. On the educational side we propose two main reforms—the extension of the present two years' post-intermediate course to a three years' course, and the introduction of a system of tutorial and individual teaching and of individual work, especially for arts students taking honours, to supplement mass-lectures.†

It seems scarcely necessary to add that we desire large increases of the teaching resources and equipment for research of the universities; but this is a demand common to all universities all over the world. We are clear, from our experience, that the universities of Bengal will be able to make good use of them. One of the most important of needs is a strongly organised University Department of Education, which will be alive to the new ideas springing up in all parts of the world, and able to put them to the test of experience, under Indian conditions, and on a small scale before applying them on a large scale.

48. At this turning-point in the history of India, the part that the Indian universities will play can scarcely be exaggerated. It is hardly

* Only a small number of the colleges admit women; provision is generally made for them in special colleges.

† At present in Calcutta honours students have less time for individual work than pass students. They attend the pass lectures and others in addition.

too much to say that India's political and social future depends on her universities. I know that many thoughtful people in Bengal do not under-estimate the burden of responsibility that will fall on them.

For the adequate design of secondary education and the training of secondary teachers, suited to India's needs—one of the first tasks to which they will have to apply themselves—they will be directly responsible; for the design of primary education and the methods of training primary teachers, suited to India's needs, they will be at least ultimately responsible; and the problem of primary education in India is the largest educational problem now before the world. All that we can do in strengthening university and secondary education is only a preliminary to the solution of that last problem.

The Montagu-Chelmsford Report insists on "the immense work of education to be done throughout the countryside," on the necessity of wakening the Indian ryot's intelligence, of helping him to be "an independent, self-determining man." I think no one can face the task, and really understand it, without a feeling of something like awe at its difficulty, its immensity, its dangers.

The conditions of India, with its literate middle class, or *intelligentsia*, as the Montagu-Chelmsford Report calls it, its illiterate peasantry, are in some respects ominously like Russian conditions in the past which have led to the destruction of that *intelligentsia*. Fortunately, under British rule, other conditions have been very different; and, if we may trust Hunter and other observers, the Indian peasantry is very different from the Russian peasantry, described, before the war, in such gloomy colours by Tolstoi and Gorky, and other modern Russian writers.

But we have to remember that if education is to mean, as it has too often meant, literacy and nothing more, we shall be merely sensitizing an impressionable people, making them capable of reading without judgment. In the West propaganda has become a threat to stable institutions: in the East it may become a greater threat. How shall it be averted? How shall you make your education mean "training," and a social training so designed that the movement of India shall be a steady movement? Education is not itself the original cause of that movement; it comes from the spirit of the times and the rumour of the market-place; it cannot be kept out by frontier-guards or Government regulations; and the desire for education has spread to the *namasudras* of the north, to the untouchables of the south. But if education did not create that movement, I believe that it can guide it.*

49. I come to my last topic, not the least delicate. To be dealt with satisfactorily it must be faced with perfect frankness. How far will Europeans continue to play a part in Indian education? Mr. R. P. Paranjpye—the distinguished Principal of Fergusson College, Poona, and a former Senior Wrangler†—and many of his countrymen suggest that Europeans will soon only be needed for a few of the highest posts, and that India should follow the policy of Japan, who started her educational organisation by employing Europeans, but has replaced them entirely by Japanese trained in the Western countries of Europe and America. It is a natural and intelligible policy. But I am inclined in the first place to doubt, from what I have heard, whether Japan has not lost more than she has gained by its too rapid adoption, and, secondly, it seems to me to overlook the differences between India and Japan.

Japan is our very good ally. India is a country of the British Commonwealth, and, except for a handful of extremists, desires to remain so. India desires not Japanese institutions, but institutions modelled on those of Great Britain and developed to meet Indian needs; and though it is not vocal, there is among the *bhadralog*, the middle classes, a strong feeling that they have something direct to learn from Englishmen and other Europeans which is not testified to by university examinations and distinctions.

50. The success of the missionary colleges all over India is a proof of this. Many of those colleges—the great majority—make no attempt to proselytise, and I believe that some of the largest have only a handful of Christian students. It is for the example set by the teachers, and the whole spirit which they create, that pious Hindu

* One may look forward with some hopefulness to the Indian Y.M.C.A. efforts to link education with the co-operative movement, started, like so many other important movements, by Lord Curzon's Government, and to the investigation on missionary village education now being conducted by the unofficial Commission presided over by Mr. Andrew Fraser. The suggestion made by Dr. Henry Whitehead, the Bishop of Madras, that, departing from Western precedent, the education of the village should be begun by the education, and especially the technical education, of the adults, so that the children will grow up to take their places in an educated village, seems especially promising.

† I refer to his presidential address delivered at the Bombay Educational Conference held at Surat, as reported in *The Collegian* (Calcutta) of November 1st, 1919.

and Muslim fathers, jealous to the last degree that their children's faith shall be untouched, send them to missionary colleges, to be trained by Englishmen and, I must add, by Scotchmen—who have played so immense a part in Indian education—and by Belgians. All over Bengal I came across Indian parents who wished to send their sons to the Scottish Churches College, to St. Paul's Cathedral College, to St. Xavier's. "I want them to be under the influence of the missionaries," was a common expression; so was its variant, "I want them to be educated by Englishmen." It is less the unofficial teaching to which some Indian Chauvinists object than the official; yet Presidency College, the largest Government college, with the greatest number of European teachers (in peace-time), has the pick of the Calcutta students and turns away hundreds every year.

Indeed, I believe, if analysed, the objection in India is largely, not to European teachers, but to the present system of the Educational Service. It is a service which has secured to India many admirable teachers in the past, but I believe it must be gradually transformed into a different system—a system of *ad hoc* appointments, under which Indian institutions will feel that they are getting the best man available for each particular post, whether Indian or British. A larger number of first-rate men would be tempted (as they ought to be tempted) to go to India if they felt that by so doing they were not necessarily committing themselves for life.* India is nearer to us than it has ever been. There is no reason why good work in history, chemistry, or physics done in Dacca or Calcutta should not be as well known to historians, chemists, and physicists in Great Britain as work done in Glasgow or Manchester. Yet it is to be remembered that the field for Englishmen of enterprise has grown larger, and India may find their services more difficult to secure than in the past.

51. I have tried to see this matter from both points of view. The old tag of Mr. Kipling's, "East is East and West is West, and never the twain shall meet," has a context which is not often quoted. It provides a meeting-place for the brave of all races. In the War men of the East and of the West have fought together for a new and high ideal. I am one of those who regard a new departure, sanctioned or about to be sanctioned at this historic moment by Parliament, as the only way to safety in India. But those who look on the situation as in itself an easy one or a safe one must be indeed ignorant or devoid of imagination. It is one that needs high courage for all concerned; a common-sense and decision less common in India than the logic of the schools; the *esprit de finesse*—I will translate the phrase boldly by "sense of reality"—which the high-souled Pascal demanded of the thinker, as well as the *esprit géometrique*, the mathematical sense, in which so many Indians excel; and, lastly, the stern power of saying "No," in the public interest, where it would be easy and gracious to assent.

I believe profoundly that in the new education of India the need for the help of Englishmen, strong of heart and mind, will be great. I hope that Englishmen will give that help. I hope that India will welcome it.

May I end on a personal note? I feel how much I owe in my experience of India to two Indian colleagues, Sir Asutosh Mookerjee and Dr. Zia-ud-din Ahmad, whom to know is to admire; and I desire to express my appreciation, not only to them, but to the other teachers and administrators, Indian and European, who have striven to redeem a faulty system by loyal co-operation and by personal service and ability of a high order.

I am conscious of the imperfection of this sketch, in which I have set myself rather to point out what remains to be done in Indian education than what has already been achieved. It would be still more imperfect if I did not say that, in spite of what I have seen, and because of what I have seen, I have faith in the educational future of Bengal and of India.

DISCUSSION.

THE CHAIRMAN (Sir William Duke) said that after the extraordinarily interesting and eloquent paper which had just been read, he was sure they would all appreciate the main outlines of the great educational problems of India. They would also be satisfied that, in view of the work which had been done by the Calcutta University Commission, the authorities who had in future to make decisions on educational matters would have very clear guidance before them. Lord Meston's absence was especially unfortunate, because he could have given them his opinion on what lay at the root of all progress, finance; he was one of the greatest authorities on Indian finance. The educational burden which the ratepayers of Great Britain had to bear had increased of late years, but even at the maximum which had been attained they could not

* The substitution of a system of tenure for a given number of years with a retiring bonus instead of life-tenure would be a useful and important innovation. It has been recommended for certain cases by the Calcutta University Commission.

pretend that their teachers were well paid and that the remuneration accorded well with the dignity of their profession. The Primary School teachers in India worked under miserable conditions, and it had been a keenly discussed question between himself and some of his Indian friends as to whether quantity or quality was the more important. Both were most urgently required. The expenditure on education in India would have to be increased enormously, and in that connection he would have liked to have heard Lord Meston's views as to what proportion of that increase could be borne by the Government and what proportion should be found by the voluntary efforts of the people, though it really came to the same thing in the end; the money had to be found by the people either directly or through their agent, the Government. Another point to which he would like to refer was the interesting controversy as to the language which should form the medium of instruction. As a result of his experience and observation in India, he thought that whichever system was followed — whether instruction was given in the vernacular or in English—the essential thing was that the language chosen should be thoroughly acquired and be the medium of the student's thought. The pupil should not be hampered by having to struggle simultaneously with the difficulties of a subject and the difficulties of the language in which that subject was taught. One hundred and fifty years ago it would have been unthinkable that instruction in Western subjects could be given in the vernacular, just as in the thirteenth century it was unthinkable that education could be given in Western Europe through the local dialects of that period. He believed, however, that there was no great advance in Western Europe until education ceased to be given through the medium of Latin and began to be imparted in the vernaculars, which by that time had become fit media to convey it. That either pointed to a day when the rapidly-improving Indian vernaculars would have become flexible enough for the purpose, or to a time when English would be taught so early and thoroughly in India that the children would be bi-lingual. Indians would have to make up their minds in the future to what extent they desired the help of Englishmen in education. On the whole, he was sure that there were certain subjects, or rather purposes, for which Indians would not willingly relinquish the advantage of having the best brains of the English universities to help them; and he hoped that no career would appear more honourable to the young men of our universities than that of assisting in the progress of education in India.

THE SECRETARY of the Section then read the following extract from Lord Meston's letter: "My interest in Indian education is very great, as must be that of anyone who has been associated with the recent administration of the country. An enormous amount of valuable work has been done, but we are still on the threshold of the great problems which Mr. Hartog and his colleagues have been endeavouring to solve. It seems to me that the time has come for the establishment of a great National Trust in which the generosity of India and its friends should be mobilised to provide at least some part of the vast funds necessary for wise progress and adequate liberality to our schools and colleges. It would provide a much-needed means by which State aid could be supplemented and private enthusiasm could be enlisted in the directing and influencing of educational progress. I think there is room for such an organisation without any conflict with the sphere of the universities or of the Government, and it seems to me almost an inevitable concomitant of the coming constitutional changes."

MR. H. R. JAMES, M.A., late Principal of the Presidency College, Calcutta, said that when he first heard in 1917 that the Calcutta University Commission had been appointed he had wondered if it was not rather superfluous. He remembered the Indian Universities Commission of 1902, and he thought that the results of that Commission, which were embodied in the Universities Act of 1904 and the new Regulations of the Calcutta University, had given them tasks which it would take many years to work out; and as the new ideals and standards only got into full working order in 1910, it seemed that they had not yet been given a fair chance. He had begun to change his mind when he learned of the *personnel* of the 1917 Commission: Sir Michael Sadler was an ideal President, and in Mr. Hartog he knew the Commission would have the services of a man who talked more sense about examinations than anyone else he had ever heard. He (Mr. James) had been completely converted when he obtained the five volumes of the Commission's report; and if that had not quite converted him he would certainly have been converted by the admirable and lucid paper which Mr. Hartog had read that afternoon. He entirely agreed with the division between school and college education which the Calcutta University Commission had advocated, but he felt some doubts about their intermediate colleges. He doubted whether two years of instruction would suffice for that social education which every school and college ought to give. The 1917 Commission mentioned that the Commission of 1902 desired the abolition of what were called the Second Grade Colleges. He did not know whether Mr. Hartog had ever come across the reports of the two Commissions of 1905-06—Commissions which had inspected the colleges under Calcutta University. The suggestion was made in one of those reports that the Second Grade Colleges should not be abolished, but amalgamated with the High Schools out of which they had originally been formed. He still thought that was the best solution of the problem, although it had been considered and put aside by the Calcutta University Commission.

He quite agreed that it would be impossible to convert all the schools of Bengal into schools of that higher type, but the number of intermediate colleges suggested was only thirty, and he thought that thirty, or even fifty, of the schools could be converted; the gain to school education would be very great. It was said that education in those new institutions was to be by school methods and the age was to be the school age; perhaps then it would be well to make them completely into schools and call them "Collegiate Schools." Dealing with the question of the Intermediate Board, he quite recognised the gain that would be secured if a new Educational Authority could be set up which would have the full support of public opinion, but he noticed that the powers which were to be made over to the new Board were tremendous. It would take over a large number of the powers at present vested in the Education Department, the Universities, and the Government, and particularly the great financial power of the distribution of all grants. He rather doubted whether from fifteen to eighteen persons of the required competence and leisure—for apparently they were to be an unpaid body—could be found to undertake these vast responsibilities. He welcomed Mr. Hartog's remarks on the meaning and purpose of examinations. Examiners should always bear in mind that an examination was only a means to an end. He also agreed with Mr. Hartog on the language question. He had once ventured on the paradox that English was the vernacular of higher education in India. There was salvation to be hoped for from the blessed word "bi-lingual." Although a time would come when Bengal would be able to provide all the teachers that were necessary for its people, he did not think that time had yet arrived. The best successes of education had been won in the past through the co-operation of Englishmen and Bengalees, and he thought that would continue to be the case for some time to come. He was greatly pleased with Mr. Hartog's accurate reference to Kipling. His lines were too often quoted in a sense just opposite to their true significance; what they signified really was the oneness of East and West in all essentials.

Mr. Bhupendranath Basu said he was glad to be able to join with the previous speakers in expressing his appreciation of the valuable work which had been accomplished by the Calcutta University Commission. In view of the difficulty of the subject with which that Commission had dealt, it would have been impossible for them to have expressed their views in a more condensed form; and although their five-volume report required time to assimilate, there were many men in his province—Bengal—who would devote their attention to the perusal of it. If it had been possible, while the Commission was still in India, to have a series of lectures like the one which Mr. Hartog had given them that day, delivered say in the town hall of Calcutta, he thought their labours would have been better appreciated in India; because it was not very difficult to get hold of particular portions of the report which were not altogether agreeable to Indian sentiment, and use them to create misapprehension in the public mind about the labours of the Commission. Indians had now got to face the problem of education, and they were not dismayed at the vastness of the problem. They realised that the importance of the work demanded the thorough investigation which had been given to it by Mr. Hartog and his colleagues. He had been preceded in the discussion by his old friend Mr. James, and he would like to express to him the deep regret that was felt in Bengal at his early retirement from the education service; he had done invaluable work, and his loss was deeply felt. He had mentioned that because it bore on the point raised by Mr. Hartog as to whether the help of Englishmen was still required in education in India. He was one of those who thought that their co-operation and assistance were still required. He did not mean to imply that Indians were incapable of taking charge of their own education—if that was so, they would not be fit to receive the new powers and responsibilities with which they were to be entrusted; but he had always felt that the best places where the minds of India and England could meet and work for their mutual benefit were the colleges and universities of India. There they were removed entirely from political questions and considerations of a political character. English professors and Indian students met, not as members of different communities, but as members of the same body, the educational body of India, inspired by the same ideals and working harmoniously towards a common end. In his student days there were no Indian teachers in their colleges, but only Europeans; and he had the liveliest sense of gratitude for the many advantages he had derived from association with those teachers. He had learned to appreciate what was best in both English and Indian life; and having regard to the peculiar position which India occupied as part of the great Commonwealth of the British Empire, to which they were proud to belong, he did think that that constant and intimate association, in a domain other than political, was fraught with the greatest possibilities both to India and England. He would, therefore, be sorry to advocate a policy which involved the complete dissociation of English educationists from the work of Indian education, and he hoped that the new conditions which would shortly be introduced into the Indian Educational Service would attract the best products of the English universities. With regard to the question of the language in which education should be carried on, he thought that at the present time higher education in India could only be conducted in English. The ancient position of India as an isolated country, cut off from the rest of the world by mountains and the sea, had gone for ever.

They wanted to be in touch with the intellectual movements that were going on outside India, and the only vehicle by which that could be done was the English language. Possibly some other European language might answer the purpose, but it was well known that English was becoming an almost universal language amongst educated men, and therefore it was incumbent upon Indians, quite apart from all political considerations, to be able to express their thoughts in English, and to understand English without an effort, and that result had been achieved. For an educated Indian, an English mathematical or historical book was as easy to understand as it was for an Englishman. In spite of the high perfection which the Bengal vernacular had attained, they had not yet got a vernacular in India which could give expression to metaphysical, mathematical or scientific subjects without borrowing from Sanskrit, and if that was done the words became as difficult as foreign words. Indian young men were keen on learning not only English, but other European languages; they had got a philosophical turn of mind, and wanted to learn German so as to be able to read Kant in the original, and they also wanted to learn French. He did not think, therefore, that for higher education in the universities bi-lingualism would be at all helpful. The true solution was that up to a certain age the education should be entirely in the vernacular, and after that age was passed English should be gradually introduced, so that by the time a boy reached the university standard English could be the sole medium of his education. The solution of the problem of secondary colleges was not, in his opinion, the solution which the Commission recommended. The present Matriculation standard of their universities was much too low and elementary. Boys began specialisation immediately after Matriculation, and as a result a boy who had taken his M.A. in mathematics might not know a word of history or any geography at all. The true solution was to advance the Matriculation standard, and the present minimum age of sixteen ought to be advanced to eighteen; specialisation should not begin until the university standard was reached. That was a practical solution. He would conclude by adding his testimony to that of the distinguished and appreciative audience to the lucidity and ability with which Mr. Hartog presented the salient features of university education in India.

Sir George W. Forrest, C.I.E., said forty-nine years had passed since he commenced his official career by entering the Bombay educational service. During the fifteen years he had the honour of belonging to the Indian Educational Service he had enjoyed varied experience, and had found as a rule that greater success was attained when the students lived in college, as was the case at the Deccan College. With reference to the question of English teachers in India, the great work which had been done by eminent English professors in the past ought not to be forgotten, and he thought it would still be wise to utilise the services of a certain number of Europeans as pioneers of higher education. It was, however, becoming increasingly difficult to obtain the best men for the work, owing to the multiplication of openings at present available for Englishmen of initiative and resource. It was not so much the actual teaching as the coming into contact with the Indian students which was so valuable. It would be hard to exaggerate the influence which Wordsworth, Oxenham, Selby, and Macmillan had in moulding the character of the students, who would be a credit to any university. When he went to Calcutta he thought one of the great drawbacks of the Presidency College there was its distance from the European quarter. In Bombay, happily, that was not the case, and the constant intercourse between Indians and Englishmen who were united by a love of letters was a great benefit to the University. He was delighted to hear of the impending doom of the Matriculation Examination, which had, he thought, done more injury to Indian education than anything else. People came in shoals to take that examination, although they were totally unfitted for it, simply because it was a passport to Government service. It would be an impertinence on his part to compliment Mr. Hartog on his paper, but he hoped it would lead all who heard it to read the first two volumes of the Commission's report. He had read a large number of blue-books at one time or another, but he did not think he had ever read a more statesmanlike report than that which Sir Michael Sadler and his colleagues had drawn up. He did not agree with it in all particulars, but he did think it was one of the finest reports that had ever been printed, and he hoped one day to be able to suggest to Mr. Fisher, in order to make them realise what was the true aim of education, that portions of it should be printed and circulated to teachers at home and our university dons. He had great pleasure in proposing a hearty vote of thanks to Mr. Hartog for his paper.

The vote of thanks was seconded by the Chairman, and carried unanimously.

Mr. Hartog, in reply, said that in view of the lateness of the hour, he would deal in writing with the suggestions that had been made with reference to the Indian colleges. He would like to tell them an experience he had had in one of the Bengal colleges. He had listened to a lecturer speaking on an English text. He spoke for the full hour allotted to him at a very rapid rate, and after the lecture was over asked him (Mr. Hartog) for his opinion on it. He told him that in England or France the pupils would have done at least half of the talking in asking or replying to questions. A short time after he received a letter from the lecturer, which ran somewhat as follows: "I thought over your suggestion, and decided to try it

in my first and third year classes. I dared not try it in my second and fourth year classes, because the pupils might have failed in their examinations. In the first year classes I got no result, because the pupils were incapable of asking any questions, but in the third year class they asked me questions one of which I was unable to answer. When I was lecturing on 'Paradise Lost,' a student asked, 'Why does Milton put into Adam's mouth the expression "in my mother's lap?"'" It was somewhat remarkable that it should have remained for an Indian boy to discover that anachronism.

[NOTE.—In accordance with the suggestion of the Secretary I put into writing a few remarks arising out of the preceding discussion. I welcome most heartily Lord Meston's proposal for the foundation of a great National Trust for education in India. Such a Trust, if administered with the help of expert opinion, would be especially valuable in assisting new ventures of existing educational institutions, as well as new foundations in their early years. I hope that Lord Meston's important proposal may be taken up in India by the wealthy and public spirited men to whom it should appeal. The news of Sir Rashbehary Ghose's recent gift to the University of Calcutta of over 11 lakhs of rupees (say £130,000), added to his previous benefaction, is of good augury for the future. The criticisms which Mr. H. R. James has added to his generous praise of the work of the Calcutta University Commission clearly deserve attention. Mr. James thinks the two years' course proposed for the Intermediate Colleges too short to impart the "social education" which ought to be given by a school or college. That point was put to the Commission by the Rev. Garfield Williams, another experienced head of a college, and the Commission also considered the reports referred to by Mr. James. The Commission has proposed that in certain cases the Intermediate Courses should be added on to the top classes of the existing high schools (the lower classes receiving possibly a separate organisation), but it was impossible to propose such a scheme for universal adoption. The existing "Second Grade" Colleges, and those "First Grade" Colleges which decide to limit themselves in future to intermediate education cannot be left out of consideration; moreover, for geographical reasons, it may be desirable to establish new Intermediate Colleges in places where there are no suitable high school classes at present to combine with them. It seems to me personally that at a later stage it may be possible to add on one or two high school classes to all the Intermediate Colleges which do not possess them, and so to meet the views of Mr. James and Mr. Garfield Williams, for which there is much to be said. I fear that I cannot in the brief space at my disposal deal with Mr. James's doubts as to the powers to be conferred on the Board of Secondary and Intermediate Education. Every scheme of this kind must necessarily be of the nature of an experiment, just as the foundation, some thirty years ago, of County Councils in this country was of the nature of an experiment. We had placed before us, very fully, doubts similar to those expressed by Mr. James, but we believe the scheme which we propose to have a greater chance of success than any other which was proposed or which occurred to us. I desire finally to say that though I hope that in those portions of my paper and of this note which deal with the work of the Calcutta University Commission I have reproduced the views of the Commission accurately, I must not be regarded as their official spokesman.—P. J. H.]

CORRESPONDENCE.

POWER FROM THE SUN.

Referring to the subject of Mr. Campbell Swinton's letter on pages 94 and 95 of the *Journal* of December 26th, may I point out that quite a small child can gently press against a heavy open door, and so close it? But a rifle bullet fired at the door would go clean through it without moving the door at all, unless the latter were ironclad or protected by a very thick covering of yielding material, such as we use in ballistic experiments.

The problem is to find the armour or "sandbag" on which solar radiation may be made to do useful work.

W. H. MASSEY.

GENERAL NOTES.

THE MICROSCOPE: ITS DESIGN, CONSTRUCTION, AND APPLICATIONS.—The Faraday Society, the Royal Microscopical Society, the Optical Society, and the Photomicrographic Society in co-operation with the Optical Committee of the British Science Guild, meeting in joint session, will hold a symposium and general discussion on "The Microscope: its Design, Construction and Applications," on Wednesday, January 14th, 1920. The meeting will be held in the rooms of the Royal Society, Burlington House, Piccadilly, W. 1 (by kind permission of the President and Council), and it will extend over two sessions: from 4.30 to 6.30, and from 8 to 10 p.m. The meeting will be presided over by Sir Robert Hadfield, Bart., D.Sc., D.Met., F.R.S., President of the Faraday Society, who will deliver an opening address, and Mr. J. E. Barnard, President of the Royal Microscopical Society, will then give a general survey of the subject, and he will be followed by Sir Herbert Jackson, K.B.E., F.R.S. Professor F. C. Cheshire, C.B.E., will then speak on the Mechanical Design of Microscopes, and a paper by Professor A. E. Conrady, on Microscopical Optics, will be presented. Further particulars may be obtained from F. S. Spiers, Secretary, The Faraday Society, 10, Essex Street, London, W.C. 2, or C. J. Lock, Secretary, The Royal Microscopical Society, 20, Hanover Square, London, W. 1.

POWER-PLANT OF THE PANAMA CANAL.—Some particulars are given in *The Engineer* of the plant and machinery of the Panama Canal. The power required is obtained by utilising the flow of surplus water over the Gatun Dam, the height of which above sea-level enables an average effective head of 75 feet to be realised throughout the year. The power-plant at first installed comprised three turbines, each of a rated value of 2,250 kilowatts when running at 250 revolutions per minute and supplied with 500 cubic feet of water per second. A flow of 500 cusecs, with a fall of 75 feet, produces nominally 3,160 kilowatts, so that there is an efficiency margin of 37 per cent. The demand has been found to be much under-estimated, and it has become necessary not only to provide three additional machines of greater capacity, but also to increase the output of the existing generators. Of the three additional machines, only one is yet in position, but when the installation is complete there will be three units of 2,880 kilowatts each, and three units of 4,500 kilowatts each, totalling 22,140 kilowatts, and requiring a supply of just over 4,000 cubic feet of water per second. The electric energy is employed to drive the machinery of the locks at Gatun, Miraflores, and Pedro Miguel, of the haulage locomotives, of the permanent machine-shops, of the dry dock, and of the coal-handling plant, besides lighting the locks, and many towns comprised within the canal zone.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 12...Brewing, Institute of (London Section), Imperial Hotel, Russell-square, W.C., 8 p.m. Mr. F. Ayton, "Electric Traction for Brewers."

Surveyors' Institution, 12, Great George-street, S.W., 8 p.m. Messrs. E. M. Konstam and C. H. J. Clayton, "Land Drainage from the Administrative and Engineering Point of View."

Geographical Society, Kensington-gore, W., 5 p.m. Captain H. Thomas, "Geographical Reconnaissance by Aeroplane Photography."

TUESDAY, JANUARY 13...Electrical Engineers, Institution of (North Midland Section), Hotel Metropole, Leeds, 7 p.m. Messrs. A. G. Ellis and J. L. Thompson, "Large Power Transformers."

Royal Institution, Albemarle-street, W., 3 p.m. Sir John Cadman, "Modern Developments of the Miners' Safety Lamp."

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. 1. Mr. J. Mitchell, "Whitby Harbour Improvement." 2. Mr. R. F. Hindmarsh, "The Design of Harbours and Breakwaters with a View to the Reduction of Wave-action within them." 3. Mr. J. W. Sandeman, "Wave-action in Harbour Areas, with special reference to Works for Reducing it at Blyth and Whitby Harbours." 4. Mr. W. Simpson, "The Improvement of the Entrance to Sunderland Harbour, with Reference to the Reduction of Wave-action."

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 7.30 p.m. Mr. A. C. Bawtree, "Colour: its Fundamental Laws and Scientific Method of Recording."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Major G. W. C. Kaye, "Some Aspects of Radiology."

Anthropological Institute, 50, Great Russell-street, W.C., 8.15 p.m. Dr. A. C. Haddon, "The Outrigger of Indonesian Canoes."

Colonial Institute, Central Hall, Westminster, S.W., 8 p.m.

Horticultural Society, Vincent-square, Westminster, S.W., 3 p.m.

WEDNESDAY, JANUARY 14..ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 3 p.m. (Juvenile Lecture.) Mr. L. Pendred, "Railways and Engines." (Lecture II.)

Electrical Engineers, Institution of (Wireless Section), at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Captain R. J. Round, "Wireless Direction and Position Finding."

United Service Institution, Whitehall, S.W., 3 p.m. Major A. C. Smith, "The Traditions of the British Navy."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Professor W. de la Mare, "Islands; and Robinson Crusoe."

Faraday Society, Royal Microscopical Society, Optical Society, and Photomicrographic Society, in co-operation with the Optical Committee of the British Science Guild, at the Royal Society, Burlington House, W., 4.30 and 8 p.m. "Symposium and General Discussion on the Microscope: its Design, Construction and Applications."

THURSDAY, JANUARY 15...Ice and Cold Storage Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m.

Linnean Society, Burlington House, W., 5 p.m. Dr. B. Daydon Jackson, "Methods of Botanic Illustration during Four Centuries."

Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. L. E. Hinkel and H. W. Cremer, "The condensation of acetoacetic ester with p-dimethylaminobenzaldehyde and ammonia." 2. Messrs. G. S. Butler and H. B. Dunnicliff, "The action of alcohol on the sulphates of sodium." 3. Messrs. M. Nierenstein, C. W. Spiers, and in part the late K. C. R. Daniel, "Guarana Tannin." 4. (*a*) Mr. R. Lessing, "The behaviour of the constituents of banded bituminous coal on coking. Studies in the composition of coal"; (*b*) "The mineral constituents of banded bituminous coal. Studies in the composition of coal." 5. Messrs. P. Ray and P. V. Sarkar, "On the hydrazino-thio-cyanates of certain divalent metals."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. R. R. Terry, "Renaissance Music in Italy and England." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. C. Marriott, "Review of Members' Exhibition of Photographs."

FRIDAY, JANUARY 16...Royal Institution, Albemarle-street, W., 9 p.m. Professor Sir James Dewar, "Low Temperature Studies."

University of London, University College, Gower-street, W.C., 5 p.m. Dr. T. Borenius, "Mediæval Art." (Lecture I.)

Civil Engineers, Institution of (Students' Meeting), Great George-street, S.W., 6 p.m. Mr. R. B. Dunwoody, "The Economic Requirements for Inland Navigation Transport in the British Isles."

SATURDAY, JANUARY 17...Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. Noyes, "The Anglo-American Bond of Literature."

Municipal and County Engineers, Institution of (South-Western District), The Castle, Exeter, 2 p.m. Mr. W. P. Robinson, "A Few Notes on Road Maintenance, with particular Reference to Devonshire."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 19th, at 8 p.m. (Cantor Lecture.) CAPTAIN H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S., Fellow of Downing College, Cambridge, and formerly of the Royal Air Force, "Aircraft Photography in War and Peace." (Lecture I.)

WEDNESDAY, JANUARY 21st, at 4.30 p.m. (Ordinary Meeting.) ALFRED H. POWELL, "Ancient Cottages and Modern Requirements." The Right Hon. EARL FERRERS will preside.

Further particulars of the Society's meetings will be found at the end of this number.

COUNCIL.

In consequence of his appointment as Permanent Under-Secretary of State for India, SIR WILLIAM DUKE, G.C.I.E., K.C.S.I., has been compelled to resign his positions as Vice-President of the Society and Chairman of the Indian Section Committee.

At their last meeting on Monday, the 12th inst., the Council elected SIR CHARLES STUART BAYLEY, G.C.I.E., K.C.S.I., to fill these offices.

JUVENILE LECTURE.

On Wednesday afternoon, January 14th, SIR HENRY TRUEMAN WOOD, Chairman of the Council, in the chair, Mr. LOUGHNAN PENDRED, M.I.Mech.E., Editor of *The Engineer*, delivered the second and final lecture of his course on "Railways and Engines."

The lecture opened with a description of a locomotive boiler. The boiler is the most important part of a locomotive, for a very bad engine could be driven by a very good boiler, but the best engine in the world would be useless with a bad boiler. The boiler has to be fed just as the body is fed, and the more the power that it is desired to get from a boiler the more coal it must be given to burn. The business of a boiler is to turn water into steam by boiling it. In a first-class boiler a quarter of a pound of coal will turn a quart of water into steam. A big locomotive pulling a heavy train needs about one ton of coal every hour, and the fireman has to throw the equivalent of 40 lb. of coal per minute into the fire-box.

The question of the pressure inside a boiler was then discussed, and it was pointed out that though 150 lb. per square inch did not seem much, it meant ten tons, or the equivalent of one hundred sacks of coal, on every square foot.

A sectional model of a North Eastern locomotive lent by Sir Vincent Raven was then completely explained.

A number of slides were then shown, a set of three illustrations showing the water pick-up for filling the tender of a moving train. Others exhibited early railway coaches, etc.

The lecturer then turned to the engine, and after explaining by the help of a rough model that an excentric is no more than a greatly enlarged crank-pin, he demonstrated the working of an engine by means of a sectional wooden model which was built up before the audience, each part being explained before being put in place. The model showed the action of a flat slide valve, reversing by means of a link, and the meaning of "notching up."

Signalling was then taken in hand, the block system being described by the parallel of a long passage with many doors of which no two adjacent ones could be opened at the same time. A pair of block instruments was then shown in action, and some of the details of signalling were explained by slides and models.

The lecture concluded with a description of a run on a locomotive foot-plate and instructions how to drive an engine. A picture of the cab of a modern L. & S.W. engine was used for the purpose, and it was pointed out that the driver and the fireman had no less than twenty-two separate levers, gauges, cocks, etc., to attend to during a run.

On the motion of the CHAIRMAN a vote of thanks was accorded to Mr. Pendred for his interesting course, and in replying Mr. Pendred said he would like to take the opportunity of thanking all the people who had helped him by the loan of models and slides. He would mention first Sir Vincent Raven of the North Eastern Railway; Mr. Bowen Cooke of the London and North Western, whose representative in London,

Mr. Meacock, had given every assistance; and Sir Henry Fowler of the Midland, who had sent locomotive models. The models lent by Sir Vincent and brought up to London by Mr. Grey were exceptionally beautiful specimens. Then he had to thank Messrs. Sykes and their representative, Mr. Lascelles, and Messrs. McKensie and Holland for models of signalling apparatus; the Publicity Managers of the London and South Western Railway, Great Northern Railway, and Great Western Railway, who had been of the greatest help in various ways; and Mr. W. Hooper—who had a splendid collection of locomotive slides—for the loan of several of them. Finally, he wanted especial thanks for his assistant, Mr. Wilfrid Lewis, whose help had been simply invaluable.

THE SOCIETY'S OFFICES IN 1765.

The Duke of Bedford has very kindly given to the Society an old plan of that part of the Bedford estate where the premises were situated which the Society occupied from 1759 to 1774, when they moved to their present house in the Adelphi. It is entitled "A Plan of Houses in the Strand and in Denmark Court proposed to be sold to His Grace the Duke of Bedford by Messrs. Couts Evans & Others. And of Houses and Ground thereunto adjoining—July 31st, 1765." The plan practically covers the same area between Southampton Street and Burleigh Street west and east, and the Strand and Tavistock Street south and north, as is shown in the illustration on page 56 of Sir H. T. Wood's "History of the Society." At the time this ground formed part of the Bedford Estate, but it was sold at a later date. The plan shows clearly marked out a space of ground as "in the occupation of the Society for Arts and Sciences." No details of the buildings are given, as the draughtsman was evidently concerned only to show the particular houses which were offered for sale, and were presumably afterwards bought. In fact he left the greater part of the centre of his plan blank, and utilised the space by inserting a schedule of the rentals of the houses in question.

The space allotted to the Society corresponds with that shown in the sketch in the History, and inasmuch as the details of this sketch were partly conjectural, as it was made up from various sources, the new information is valuable because it confirms the results of the previous inquiries. The only new detail given is that the frontage to the Strand is stated as 21 ft. All that was known before was that the Society had an entrance in the Strand, but the width of it was not known.

It is highly probable that this plan is the only one in existence showing the premises occupied by the Society from 1759 to 1774, the position of which had been forgotten, and was quite unknown until the investigation was made of which an account is given in the History.

PROCEEDINGS OF THE SOCIETY.

TRUEMAN WOOD LECTURE.*

Wednesday, April 30th, 1919; Mr. A. A. Campbell Swinton, F.R.S., M.Inst.C.E., M.I.E.E., Chairman of the Council, in the chair.

The Chairman, in opening the meeting, said the present was the second of a series of lectures that had been inaugurated in commemoration of Sir Henry Trueman Wood's long services as Secretary of the Society. At the beginning of the war, in 1914, the country found itself in a very awkward position with regard to glass of all descriptions, both for the chemical trades and for optical and other purposes, by reason of the fact that this country had got into the habit of importing practically all the glass it required from Germany, Austria, and other foreign countries. As a result, there was a great shortage of glass soon after the outbreak of war, which threatened a very serious condition of affairs, because glass was required for many instruments and apparatus necessary for the carrying on of the war. Sir Herbert Jackson was asked by the Government to look into the matter, and as a result of his experiments the country was in a very short time enabled to produce glass of the different descriptions that were necessary. It was a really wonderful piece of work done in a very short space of time, and as the subject of the lecture was "Glass and Some of its Problems" he had no doubt that it would be well worth listening to.

The lecture delivered was—

GLASS AND SOME OF ITS PROBLEMS.

By Sir Herbert Jackson, K.B.E., F.R.S.

Before I begin the lecture, I should like to say how much I appreciate the privilege of being asked to give this, the second Trueman Wood Lecture. Our Chairman has stated the origin of these lectures, namely, to keep alive the memory of the long and distinguished work of Sir Henry Trueman Wood in promoting and increasing our knowledge of the arts and sciences in the best interests alike of this Society and of the nation. I am sure I express the feelings of everybody present when I say how delighted we are that he is here to-day, and when I express the hope that he may be able to attend many more lectures to be given in his honour.

It was suggested to me that this lecture should have something to do with glass, and it was hoped that there might be experiments. The production of glass is difficult to illustrate efficiently in the course of a lecture. It will, therefore, only be dealt with very briefly and

* Owing to extreme pressure of work, Sir Herbert Jackson has only recently been able to complete the MS. of his lecture. This accounts for the delay in its publication.

generally before turning to some of the problems connected with glass which I hope to make the chief part of this lecture. The Chairman, in his opening remarks, has spoken of the many varieties of glass. We hear of optical glass, window glass, table glass, industrial and scientific glass, opal glass, coloured glass, etc., all of which have many properties in common while exhibiting differences which depend chiefly upon the materials used in making them, the various proportions in which the materials are used and, to some extent also, on the methods of manufacture. It will be convenient to take window glass as one of the simplest of glasses, and briefly to consider its composition. The essential materials required are sand, chalk, and sodium carbonate. When these are heated together in suitable proportions there results a glass containing silica, or the oxide of the non-metal silicon, lime, or the oxide of the metal calcium, and soda, or the oxide of the metal sodium, combined together to form what is generally spoken of as a soda lime silicate. Of these ingredients the silica is the acid constituent, and the lime and soda are the basic constituents of the glass. Most glasses are composed of acids as oxides of non-metals, and bases as oxides of metals combined together. The chief acid ingredients to be found in various glasses are silica, boron trioxide, arsenic trioxide, and pentoxide, phosphorus pentoxide, tin oxide, and antimony pentoxide. The chief bases are the oxides of potassium, sodium, lithium, barium, calcium, magnesium, zinc and lead. Aluminium oxide, a constituent of several glasses may, in some, play an acid part and in others may act as a base. With certain reservations, this may be said also of antimony trioxide. The list is not exhaustive, but is sufficient to indicate that a number of glasses is possible from various combinations of these acids and bases. (The materials used for producing opals and coloured glasses will be referred to later.) The number of glasses made is very large, and it would take at least all the time at my disposal to describe in any adequate manner how they differ from one another in composition and in those properties which make each one suitable for the purpose for which it was devised. It may, however, be appropriate here to mention that in the great variety of optical glasses, there are many which do not differ materially in composition from glasses used for other purposes. For example, a good window glass could be made with pure materials and stirred in the process of its manufacture, so as to secure such a clear and homogeneous product as would serve as one type of optical glass. The chief general properties which are desirable in all optical glasses are identity of composition throughout the whole mass of the glass, great clearness and transparency for all the colours of the spectrum, freedom from strain arising through imperfect annealing, and durability under ordinary exposure to the atmosphere. It will be seen, therefore, that apart from considerations of special optical properties, I refer to the refractive indices and dispersive powers of various optical glasses, the main difference between them and other glasses is that the highest art of the glass manufacture is called for in their production, and great care is needed to ensure purity of the materials used and accuracy of proportions, so as not only to be able to produce glass of the optical properties required, but to reproduce it with the closest possible identity of composition. With these very brief remarks on glass generally, we may turn now to some of the problems which I thought might be interesting to consider, and the first one is how far can glass be called a solid?

A solid is defined in a dictionary as having a fixed form, and being in a state in which the component parts do not tend to move freely among themselves. With regard to glass, we may ask for how long is it fixed in form, and what are the limitations of freedom of movement which we ought to consider? It is a common experience that long straight pieces of glass rod or tubing, left supported so that their own weight tends to bend them, will bend in the course of time, and in some years will become definitely bowed. Varieties of glasses differ in the readiness with which they show this flow under stress; but not any glass is so perfectly solid as to give no indication of movement under stress if tested by sufficiently delicate means. This question of permanent stability of form in glasses has some bearing on the choice of glass for the manufacture of large lenses and prisms, and the flowing of the surface of glass under mechanical pressure comes in as a very important matter in the explanation of the mechanism of polishing glass surfaces. A great deal has already been written on this subject, and it would take too long to deal with it here. Another reason why I refer to it but intend to leave it is that I hope it will not be long before the published papers and other work of Sir George Beilby, on the influence of mechanical disturbance on the physical state of a very large number of substances, will be brought together into one connected story,

when it will be seen that this subject of polishing glass has been dealt with in a comprehensive manner, and that the principles underlying it are shown to have very wide application.

The question of the relative plasticity of various glasses has two important bearings which are of some interest. For many industrial and scientific purposes it is necessary to be able to seal metallic wires into glass, and early in the war some difficulties were experienced in obtaining suitable glasses. To obtain successful joints between the metal and glass without fear of the latter cracking, it was generally considered that the glass aimed at should be one which had a coefficient of expansion as close as possible to that of the metal intended to be used, and there is no doubt that this question of expansion has to be taken into account. In making a large number of glasses and in experimenting with them there did not appear to be that close connection between the coefficient of expansion of the glass and its behaviour with metal wires which was at first expected. The coefficient of expansion of copper is about double that of platinum, and the coefficient of iron is about midway between the two. Glasses were made which gave successful joints with platinum and copper wires, but which cracked inevitably with iron wire. It did not appear, therefore, that the coefficient of expansion was the only factor to be taken into consideration. It is an important factor, but not the only one, and it soon became clear from the study of various glasses that the plasticity of the glass had a great deal to do with its utility. A careful examination showed that there was evidence that in the case of soft metals, like copper and platinum, the glass in setting could pull and deform the metal wires so that no great strain was permanently left in the glass. With hard metals like iron and tungsten, it was necessary to devise a glass which had marked plasticity over such a long range of temperature that when the glass and metal joint cooled, the glass would flow and follow the contraction of the metal and so the stress would, to some extent, be relieved. And this is an example of the need of asking the question: Is glass truly a solid, and how far can a glass be made which will flow, very much less, of course, than pitch, but in an analogous manner? The other bearing of the question is on the cracking of glass vessels with rapid changes of temperature. It is clear that if the strain set up by such changes can be quickly and readily released, the danger of cracking will be very small. The coefficient of expansion is, of course, a very important factor in this respect. It is well known that vitreous silica vessels can be heated to redness and plunged into cold water without cracking, and this is, no doubt, correctly considered to be due almost entirely to the low coefficient of expansion of silica. In the case of glasses also, the lower the coefficient of expansion of a glass the better will that glass stand rapid changes of temperature; but it is possible to make glasses approximately with the same coefficient of expansion and to find one—and that, perhaps, the one with a slightly higher coefficient of expansion—which will not crack under conditions in which the other cracks readily, and a study of the two glasses shows that the more stable one is the more plastic. On the whole, perhaps, it is not too much to say that glass may be looked upon as an extremely viscous liquid so slow in its movements in some types of glass that ages might elapse before any marked change in form could be observed under a strain just short of a breaking one for the glass, while in others it is possible to show that the glass does flow, even at the ordinary temperature, to a small extent in a relatively short time.

The next problem to be considered may be also put in the form of the question: Is glass truly amorphous or vitreous or has it any crystalline structure or tendency to crystalline structure? There are many substances which can be obtained in the vitreous state and also in the crystalline state, and which can be changed from one to the other. As one example, arsenic trioxide may be mentioned. It can be produced as a clear transparent glass which slowly changes at the ordinary temperature into an opaque white substance resembling porcelain in appearance. The opaque white substance is crystalline. It is the crystalline variety into which the vitreous will be slowly but completely changed. Again, if sulphur near its boiling-point be poured in a thin stream into cold water, it sets as plastic threads, and for our purposes we may speak of this as the vitreous form of sulphur; left at the ordinary temperature, it slowly changes into the crystalline form.

Two other examples may be given which, in a way, are perhaps more closely analogous with glass, since they are solutions of substances, and not merely single substances as in the previous illustrations. Solutions of sodium acetate and Rochelle salt, obtained by adding to hot water as much of the salts as will dissolve and cooled so that no unfiltered air can enter the containing vessels, and carry nuclei to start crystallisation, remain clear and fluid at the ordinary tempera-

ture. If such a "supersaturated" solution of sodium acetate be cooled in liquid air it is converted into a vitreous solid quite clear and transparent. On removal from the liquid air its temperature rises and very soon crystallisation starts and proceeds right through the vitreous mass. The solution of Rochelle salt treated in the same way yields a similar vitreous mass, but as it warms up no crystallisation takes place. It slowly goes back to the original liquid condition. The cold vitreous sodium acetate solution may be taken as analogous to a glass from which crystals readily separate on warming up, while the Rochelle salt is analogous to a glass which shows no tendency to crystallise through the whole range of temperature from the solid form to the point at which it is a mobile liquid. Glasses are known which tend to crystallise in all degrees of readiness. As a simple glassy substance, zinc silicate may be taken. It can be obtained, by moderately quick cooling of the molten mass, in a vitreous form which is stable for a number of years—at least, some has remained with no sign of crystallisation at the ordinary temperature for twenty-two years. By heating to a few degrees above its softening point, it changes to a translucent crystalline mass. Taking a more complex glass, but still a moderately simple one, we may study the behaviour of heat on a lime soda silicate glass. The specimen of greenish glass with some large and many smaller opaque nodules in it was given to me in the early part of the war by Mr. Frank Wood as an example of glass taken out of a tank furnace. The nodules are calcium silicate, which is the least fusible silicate potential in the glass. They have been formed through the glass in the particular part of the furnace from which it was taken being at a temperature too low to keep this silicate in solution or combination, and it has separated out in the form shown. To get this glass back to a complete vitreous state again would require a somewhat higher temperature than is used in the manufacture of the glass, since the calcium silicate is itself very infusible, and the rest of the glass has to be made very fluid before such masses of this silicate can be dissolved in any reasonable time.

This glass then, in a molten state, is an example of a solution out of which a slightly soluble constituent has separated, when the conditions were suitable for that separation. It may be interesting to turn for a moment to a consideration of conditions for crystallisation, and to go back to simple glassy bodies such as zinc silicate and some borates. With all the vitreous substances which have been tried and have been made to crystallise, there is a certain temperature at which crystallisation proceeds readily, and for small ranges above or below that temperature no crystallisation occurs. Associated with alteration of temperature, there is change in the viscosity of the vitreous substances, and hence in the freedom of movement of their particles among one another. The effect of this can be well seen when a crucible full of molten zinc silicate is removed from the furnace. If the mass be small so that cooling is quick, it remains a glass and has to be re-heated before crystallisation occurs. With a larger quantity and consequently slower cooling, the mass may become wholly crystalline, or only partly so if some of the vitreous form reaches a temperature at which its viscosity is too great, and freedom of movement of its particles too small for rearrangement into crystals to take place. Some borates are very convenient for illustrating the change from the vitreous to the crystalline state. Boric anhydride itself has not been made to crystallise, and as might be expected, the greater the proportion of it in a borate, the less marked is the tendency of a fused mass of that borate to crystallise on cooling. Of the three borates, $CaO.2B_2O_3$, $CaO.B_2O_3$ and $2CaO.B_2O_3$, the first can be obtained vitreous by fairly quick cooling, and pieces of it can, with care, be heated again to remove the strain produced, that is to say, it can be annealed. The second crystallises from fusion much more readily, cooling has to be quicker to keep it in the vitreous state, and only small glassy pieces can be obtained, which crystallise, however, on attempting to anneal them. The third borate can only be kept vitreous in very small globules.

Statements, however, of the bulk which can be obtained of any readily crystallisable vitreous body require a certain reservation. It is well known that crystallisable bodies in the fluid state may be cooled considerably below the temperature at which they would ordinarily solidify to a crystalline mass, if they are freed from all foreign material. Water is a well known example, and among many others which could be cited, mention may be made of salol (phenyl salicylate). It melts at 43° C., and if the crystallisation of a film of the molten liquid be watched under the microscope, numerous small bubbles of gas can be seen to form during crystallisation. The gas appears to be modified air. If salol be melted, allowed to solidify and re-melted in vacuo, so as to remove all this gas, and the process repeated several

times, it is found that the molten salol must be cooled many degrees (fifty or more) below its melting-point before crystallisation takes place. A small crystal of salol will start it, unless, as can be done on small quantities, cooling has been carried far enough to increase the viscosity of the fluid to such an extent that the particles have not the freedom of movement necessary for the change to the crystalline form. So it is also with a great number of glassy bodies, and the bulk which will retain the vitreous form can be largely increased since by fusion and crystallisation several times they solidify at progressively lower temperatures, until the time comes when they get quite cold in the vitreous state. For instance, the amount of vitreous zinc silicate obtained has been raised from twenty grams at one heating up to a kilogram by five fusions. The calcium borate $2CaO.B_2O_3$ has, after several fusions, been cooled to five hundred degrees below its ordinary solidifying point. When it does crystallise and the temperature rises the recalescence is remarkably bright. Long continued heating a few degrees above their solidifying points similarly retards the crystallisation of many vitreous bodies, but it is not so effective as the alternate fusion and solidification. One reason at least is not far to seek, if the two processes be tried so that gases evolved can be pumped off and their amounts measured. The process with alternations yields much more gas in any given time. With all the glasses, simple silicates and borates, which have been studied so far, the chief gas evolved has been found to be water vapour, and with the progressive removal of it the vitreous state has been found to persist more and more. Direct introduction of water subsequently has been found to promote ready crystallisation.

In connection with the comparison of long continued heating of a melt with alternate fusion and solidification, one extreme instance is worth noting. For a special optical glass, rich in phosphoric anhydride, an experiment was tried with ammonium phosphate to find if this substance could be used in the batch mixture for the glass. A nice clear fluid melt was obtained, which was kept fluid for several hours after all traces of gas bubbles had gone. The melt was well stirred and cooled till it was quite viscous, when it was left to get cold slowly. The next morning the furnace top was found forced off, and resting on a spongy mass of about thirty times the volume of the original glass melt. The changes occurring when solidification was approaching, had evidently been accompanied by the evolution of a large volume of gas, no doubt most of it ammonia, since this substance was smelt on grinding the spongy mass up. The ground material was then fused and gave a stable glass.

Reverting to the question—Is glass truly vitreous, or is there evidence of any crystalline structure in it, and bearing in mind that glasses are known which exhibit all states of preparedness to yield crystals at some temperature or other, and that the tendency to the segregation of some ingredient of a glass is enhanced by the presence of small amounts of foreign substances and notably of water, one would rather expect to find a good many glasses in which some evidence could be discovered of the early stages of orderly arrangement of particles towards the crystalline form. So far, etching glass surfaces with hydrofluoric acid has failed to reveal any of the net-work of crystalline structure filled in with vitreous material which is sometimes described as representing the texture of glass. Tearing the surface of glass by letting a film of strong glue dry and contract on it is also stated to reveal a crystalline network. Both the etching and this method give markings, very like a network no doubt, but the figuring of the surface seems to be more correctly ascribable to surface tension. Nothing which could be called definite evidence of crystalline structure is visible with any kind of illumination under the microscope of such surfaces, but this is not to deny that the texture of some glasses may be that of a network of crystalline compounds enclosing vitreous bodies.

Certain facts, from which it appears reasonable to conclude that many glasses have something of a crystalline nature in them, have been obtained from a study of the phosphorescence of various glasses and other vitreous compounds exhibiting different degrees of readiness to pass into the crystalline state on heating. Much of the work was done about twenty years ago, but more recent experiments have not modified the conclusion then formed that a truly vitreous body exhibits no phosphorescence in ultra violet light or X-rays or under cathodic discharge. Nearly every glass shows some phosphorescence and some show it very strongly, as, for example, the glass from which X-ray bulbs are largely made, and which gives the well-known green glow when the tube is in use. If some of this glass be fused and very rapidly chilled, as for example, by making a Rupert's drop from it, the glass is practically non-phosphorescent so far as its surface is concerned. A very little distance below the surface the

chilling was not sudden enough to prevent some change of the truly vitreous to an attempt at crystalline structure, so that just below the surface, as shown by broken pieces of the drop, the glass exhibits phosphorescence. The tail of such a Rupert's drop, if heated below the temperature at which the thin thread of glass bends, is found to be strongly phosphorescent, and the glow under cathode discharge can be seen to fade slowly away towards the part which was not heated. Many observations with vitreous borates and silicates have shown similar phosphorescence, appearing more and more strongly as the vitreous bodies are made to approach the crystallising stage. There does seem, therefore, reason to state that, given a body which in its crystalline state exhibits phosphorescence, it will not do so when it is in a truly vitreous state, and to infer that if a glass be phosphorescent there is something of a crystalline nature in it. It would not be right to come to the conclusion that a glass showing no phosphorescence is free from anything crystalline, since there may be crystalline structure in it which is not in the sensitive state to be revealed by phosphorescence. It would take up too much time to elaborate this further; but generally it may be said that a number of experiments on glasses, borates, etc., go to show that in some non-phosphorescent glasses there is most likely some crystalline formation, since the introduction of minute amounts of certain bodies not usually present in these glasses, as manufactured, will render them quite markedly phosphorescent; and again, the surfaces of Rupert's drops made from these sensitive glasses show no phosphorescence. Before going on to deal shortly with some points about devitrification, I may point out that boric anhydride, which has a marked effect in preventing crystallisation in glasses and in enhancing the stability of the vitreous form, is a fatal ingredient to add to a Uranium glass if strong fluorescence in ultra violet light be aimed at.

It may be concluded from what has been said or suggested that the question whether glass is crystalline or not has a bearing on the problem of devising, manufacturing and annealing optical glasses. It has, perhaps, a more obvious bearing on the problem of producing glasses capable of being freely worked in a furnace or in the flame of a blowpipe. To the flame worker especially, a glass prone to devitrification is a source of trouble. It would take at least a whole lecture to deal adequately with all the changes noticed in the numerous types of glasses which have been studied for their behaviour in the flame. I will confine myself merely to mentioning that the segregation of less fusible vitreous bodies giving a kind of crinkled skin to the glass, separation of amorphous silicates, the formation of very minute bubbles giving a grey look to the glass, as well as true crystallisation, are all frequently referred to as devitrification. It is mainly about the last form of it that there is time in this lecture for a few remarks.

There is great variety in the behaviour of glasses in a flame. A soda-lime silicate can be made which is hardly workable at all in the flame, it devitrifies so soon; but the same glass may be worked, if heated by radiation—for instance, in a muffle furnace. At the same time, it must be understood that exposure in the muffle may bring about devitrification even quickly, if the temperature is such as to bring the glass to the right state of fluidity for re-arrangement of some of its particles in the crystalline form. It would appear, therefore, that the difference between the behaviour of the glass heated in the flame, and heated by radiation, may be explained by the difference in temperature reached by the glass in each case, and no doubt this is a most important part of the explanation. Recalling what was said, however, about the conditions for crystallisation of vitreous bodies, there is, apart from temperature, the question of purity to be taken into account. The problem is whether the readier devitrification of a glass in the flame can be ascribed solely to the surface of the glass being exposed to a very high temperature, and so for a thin layer reaching the right state of fluidity for crystallisation, or whether chemical action also plays a part, *i.e.* whether the hot gases of the flame act on the glass and assist the segregation of parts of it by disturbing the chemical equilibrium of the bases and acids of the glass. Attempts to get an exact reproduction of the behaviour of a glass in a flame by exposure of thin pieces of the same glass to intense heat by radiation, have given results showing close similarity in some glasses and great differences in others. It would be somewhat out of place, and certainly tedious in a lecture such as this, to go into the details which seem to justify the statement that a survey of the relative behaviours of a very large number of different types of glasses exposed to flames or to heat by radiation, and chemical examination of the products, leads to the conclusion that water, and to a smaller extent carbon dioxide, do act

chemically when many glasses are heated in flames, and that this action plays an important part in the initial stages at least of devitrification. As the most simple example, which I can choose, of marked difference in composition of a glassy body heated by radiation, or in a blowpipe flame, ordinary borax, $Na_2O.2B_2O_3$, may be taken. Heated in a muffle up to about 1450° C. until much of it has volatilised, the residue may, according to the time of heating and the temperature, have a composition represented by anything between $Na_2O.8B_2O_3$ to $Na_2O.15B_2O_3$; but it has not been found possible, under any conditions, in a blowpipe flame, to get a residue from borax with the proportion of boric anhydride greater than is represented by about $Na_2O.3B_2O_3$. It is difficult to ascribe this difference solely to the effect of different temperatures. With some glasses, however, there is visible evidence of the disturbing influence of the hot gases of the flame. A glass containing barium oxide, which was heated and re-heated many times by radiation of varying intensity, and which was most reluctant to show any signs of crystallisation, became in the blowpipe flame, or in a hydrogen flame, grey at once over its surface, and soon afterwards signs of crystallisation were readily noticeable. The initial grey effect was seen under the microscope to be due to numerous very minute bubbles caused apparently by the rapid absorption and subsequent evolution of gases. As the question considered here is the influence of the hot gases of a flame to hasten devitrification, there is no occasion to discuss the well-known effect of an ordinary blowpipe flame to blacken glasses containing lead or similarly reducible metals, except to say that experiments show that in many instances the process of alternate reduction and oxidation which sometimes occurs when such glasses are being worked in the flame, does also appear to hasten devitrification.

Mention was made above of the influence of boric anhydride to retard the crystallisation of glasses in which it is an ingredient. Alumina is another substance the presence of which confers upon a glass the property of working well in the flame without devitrification. More striking, perhaps, as a vitrifying agent is titanic oxide. A soda-lime silicate glass was made which could not be worked in a flame at all so readily did it devitrify. The substitution of a small amount of its silica by titanic oxide converted the glass into one which could be heated and worked in the flame almost indefinitely without visible change. The statement "without visible change" is true of the behaviour of this glass; but some, and notably very soft glasses containing titanic oxide, become coloured in the ordinary blowpipe flame through reduction of this oxide to a lower state of oxidation. Zirconium, tin and thorium oxides, have been found to promote the stability of the vitreous state in a number of glasses prone to devitrification in the flame. They are mentioned as being of the same chemical family as silica and titanic oxide; but to deal with the effect of a number of rarer compounds not generally employed in glass-making would take up too much of the rest of the time at my disposal. Arsenic and antimony oxides may also be put among substances which render glasses less liable to devitrification; but glasses containing these oxides are not suitable for ordinary working in the blowpipe, since they darken in the reducing area of the flame. Tin oxide, mentioned above, is also not a generally suitable ingredient, since some glasses containing it darken badly through reduction in the flame, though others can be made which are quite workable except in the hottest kind of blowpipe flame.

I must leave out of consideration the relation of general composition and of varying proportions of ingredients to the tendency of glasses to devitrify, and content myself with the remark that for glasses of comparable composition those containing soda only as the alkali are usually found to devitrify more readily in the flame than those in which the alkali is potash, or a good proportion of potash with soda.

In this lecture it will only be possible to deal more or less briefly with opal and coloured glasses. Many vitreous bodies which crystallise fairly readily when heated can be seen to pass through a stage in which the material segregating from them appears first as an opalescence increasing in density as the heating is continued and finally passing into a visibly crystalline form. A glass approximating in composition to $Na_2O.CaO.8SiO_2$ shows this opalescence well before small crystalline nodules appear similar to those in the tank glass referred to earlier. Various silicates and borates of calcium, barium and magnesium show the same kind of phenomenon more readily and, by quickly cooling when a stage of dense opal appearance is reached, sections (or, what is just as good for the purpose, the finely ground glassy material mounted in Canada balsam) can be examined under the microscope and the opal effect shown to be due to the scattering of light by numerous small

transparent globules. Any glass from which, on cooling, part of it segregates out in very small particles evenly diffused through the mass, may be called an opal glass whether the fine particles are crystalline or amorphous, but the usual opals owe their milkiness to globules, in which no evidence at least of the crystalline state can be found. Under the microscope the globules, if sufficiently visible as distinct particles, appear vitreous and transparent, just as in milk the fat globules are seen to be themselves colourless and transparent. Among the many substances which can be used to produce opal glasses, the most common are fluorides such as calcium fluoride, cryolite the double fluoride of sodium and aluminium, and calcium or sodium phosphate, less commonly the arsenates of these metals. These substances can be included in the batch mixtures of ordinary soda or potash lime glasses, or lead glasses or zinc glasses. In the making, opal glasses are usually clear at a high temperature and "strike" opal on cooling. To what extent the glass has to be cooled before becoming opal depends on the concentration of the particular opal-producing compound which is held in solution in the very hot glass. Opal glasses produced with phosphates "strike" generally speaking at higher temperatures than those made with fluorides, the compounds formed in the glass by the latter being more soluble than those due to phosphates, at least in the case of most opal glasses made on a commercial scale. Whatever opal-forming material is potential in the molten glass, if its concentration be great, the glass "strikes" opal quickly and with relatively little cooling and becomes a denser opal as cooling proceeds, until the stage is reached when no more material segregates. Just, however, as in the crystallisation of an ingredient in a glass, cooling may occur so quickly that a state of viscosity is reached in which crystallisation cannot proceed, so with opal glasses the concentration of the opal-producing material may be such that only a little of it comes out of solution before the viscosity of the glass gets too great to allow of further separation. With still less concentration, moderate-sized pieces of the glass may even solidify in a perfectly clear condition, but again, just as re-heating will often cause a glass which has cooled vitreous to become more or less crystalline, so re-heating the intended opal glass will cause it to "strike." This can be illustrated by blowing a bulb from a tube of an opal glass. If the bulb be not too thick, and the concentration of the opal-forming material be not too great, the glass will go quite clear in the flame and the blown bulb will remain quite clear on cooling. If the bulb be then again heated gradually in a flame, the whole process from a mere trace of opalescence to a very dense opal can be watched. If during the various stages of opacity the light transmitted through the glass be observed, it will be seen to change from light orange yellow to darker and darker orange and orange red, until no more evidence of colour is seen, but only a general translucence. If thin sections (or ground-up pieces mounted in Canada balsam) of the opal glass in the various stages be examined under the microscope no separate particles in the earlier stages will be seen, even with lenses of large angular aperture, though their existence can be inferred from the opalescence which is to be well seen under the microscope with suitable black ground illumination. In the later stages of denser opal, separate particles are visible, and are seen to be progressively larger as the density of the opal is greater and greater.

When an opal glass is required for articles, the making of which involves working the glass in a muffle or in the flame, it is important that the separated globules shall not tend to aggregate or to pass into the crystalline state, otherwise the glass is found to have a rough surface. To guard against this, too great concentration of the opal-forming material must be avoided, and some workers prefer a glass which does not reach its full opal until it has been in the annealing oven. As a general experience with a wide range of all kinds of opals, it would appear that fluoride opals are more kindly in working than phosphate opals. This is more especially true for the denser kinds of opal. For merely opalescent glasses, phosphates give quite good results, but with greater concentration of the opal-forming substance there is a tendency towards crystallisation, which is more marked as a rule in the phosphate than in the fluoride opals. A dense opal suitable for working in a flame should "strike" opal even in thin pieces on removal from the flame, and should stand long-continued heating without losing its fine polished surface. When such a glass while opal is drawn out into a rod and longitudinal sections of the rod are examined under the microscope, the globules are to be seen egg-shaped or even elongated into minute rods. If an end of the opal rod be heated again to softening point and sections of that end be

examined, the opal-forming material is seen to have gone back to spheres, showing that even when separated out the opal material has about the same softening point as the rest of the glass. It is easily to be understood that if it has not, and the globules are of appreciable size, a glass containing them cannot be worked without roughening. One more point may be mentioned before concluding this short general account of opals. A glass may be required which, while remaining clear in thin pieces after removal from the flame, will "strike" on re-heating so readily that the temperature needed to develop the full density of the opal is not high enough appreciably to soften the glass and so cause deformation. One way of securing this behaviour is to add as an ingredient a small amount of a substance which will produce a trace of a compound insoluble in the glass except at very high temperatures. In the flame this compound persists as a slight turbidity and appears to facilitate the "striking" by affording nuclei on which the opal material can collect.

Coloured glasses are sometimes divided into two main groups: (*a*) Those in which the colouring matter is diffused in very small particles throughout the glass, and which may be likened to colloidal solutions; and (*b*) those in which the colouring substances are in a state resembling that of solution, and which may be likened more nearly to aqueous solutions of coloured salts. Just, however, as in aqueous solutions there may be traced or inferred all grades of subdivision of the colouring matter from separate particles which can be revealed by their scattering action on light, and which may be seen in the ultra microscope, through smaller and smaller particles scattering light less and less obviously down to those in the extreme state of subdivision frequently described as that of true solution, so in glasses similar grades of subdivision of their colouring matter may be seen or inferred.

It is in fact, impossible sharply to divide coloured glasses into these two groups; but it can be said of certain glasses that they are typical of group (*a*), and among the more common of these may be mentioned those owing their colours to the presence of gold, copper, and selenium. It is generally considered that these colouring agents exist in the glasses as metallic gold, metallic copper and elementary selenium respectively, and the varying colours which can be obtained in each case appear to depend on the state of division of the colouring agents, or at least to be associated with it. How far there is evidence that selective absorption of light has also to be taken into account, is a question which can hardly be dealt with in a short time.

With gold the colours most readily obtainable range from red to blue, through varying stages of purples. With copper in the metallic state the common colour is red; but it is possible to get variations very similar to those seen in gold glass, and a copper glass giving a definite blue by transmitted light has been obtained. It is to be understood that this blue was not due to copper in an oxidised condition, but to metallic copper. Selenium glasses are also generally red, but again states of division of this material can be secured which give other colours, although it is difficult, except on a very small scale, to obtain other than greys or neutral tints. With each of the glasses, in which gold, or copper, or selenium is present, quick chilling of the molten glass will, as in the case of opal glasses, yield a clear and colourless glass, and the greater the concentration of the colouring agents, the more sudden must the chilling be to secure this result. On re-heating these colourless glasses they, like the opals, "strike" and yield the colours which could have been obtained by slower cooling of the molten glasses. It may be of interest to deal with a gold glass a little more in detail. It is not easy to get a strongly coloured glass with gold added, in the form of gold chloride, to the batch mixture of an ordinary soda lime glass. Among the substances which enable one to prevent gold separating from the molten glass in the ordinary metallic state, the commonest used are the oxides of lead, tin and antimony. Bismuth oxide acts similarly, and so also does uranyl oxide. There are physical and chemical problems of much interest involved in this behaviour of these oxides; but it would lead us too far into technical details to attempt their discussion here. A gold glass containing oxide of tin may be chosen, because it can be made so that its behaviour can be studied either in the furnace or in a blowpipe flame. With a suitable concentration of the gold, and very slow cooling of the melt, all the ranges from red by transmitted light to a pale blue can be observed, and if rods are drawn out from the pot at intervals, and examined in a beam of light, it will be seen that, starting from a fine deep red by transmitted light, through the various stages of reddish and blueish purple and blue to the pale blue, there is progressively more and more marked scattering of the light, and the rods look more and more of an opaque

brown colour by reflected light, until in the later stages the appearance of precipitated gold is so marked as to leave no doubt that what has occurred has been a progressive aggregation of the gold into larger and larger particles. Microscopical examination of the glass at the different stages, gives clear confirmation of this and of the great similarity in the manner of separation of the gold to that of the materials which give opal glasses. Remarks made under opals and crystallisation of glasses about the influence of changing viscosities apply also, in a general way, to gold glass. There is one point in this connection which is worth referring to. If the suddenly chilled and colourless glass be returned, in small pieces at a time, to a pot in a furnace at a high temperature, about 1400° C., the glass can be melted and the gold still retained in it without appreciable loss by separation into the ordinary metallic state; but if it be slowly heated up it passes through the stages of colour previously described and, after complete fusion at a high temperature, practically all the gold will be found in a button at the bottom of the pot. Now, except in the case of a very soft gold glass, heating and working the colourless glass in the flame will only give a red glass, and no passage through the other stages is seen, or, in general, if the glass at any of the stages of colour be worked in the flame, the change of colour is but slight. The explanation seems to be that, throughout the mass of the glass the temperature never reaches high enough to give the state of viscosity for free aggregation of the gold particles, while, on the immediate surface of the glass the temperature may be so high that the gold is retained in solution, as it is in the highly heated furnace. It is very difficult to get a gold glass to behave like some opal glasses, in the sense that it will go clear and colourless in the flame and remain so when quickly cooled; but a copper glass can be made, in a similar manner with tin oxide, which will go quite colourless in the flame. Bulbs can be blown from it which remain white on cooling, and the gradual "striking" of a deep red colour observed on gently re-heating in the flame. It has been noticed in experiments with some copper glasses that, in the initial stages of "striking," the colour which develops is not red, but a dark neutral tint with a suggestion of olive green in it. This may be from copper in the very finest state of division in which it can exert visible action on light, or it may be due to the presence of traces of oxidised copper in the glass giving rise to the well-known dark compounds of cuprous and cupric copper. Certainly very dark glasses of rather similar tint can be obtained by intentionally allowing some oxidation to take place in the making of a red copper glass, or by fusing together a reduced copper glass with one in which the copper is fully oxidised. At the same time it is worth noting, and is perhaps suggestive, that a chilled and colourless gold glass which goes through the stages of very pale red to a fine full red on heating in the flame has, after six months' exposure to the β rays of radium, only developed a dusky neutral tint. A piece of glass of the same composition, except that there was no gold at all in it, has not been affected by the radium. It would lead too much into theoretical discussion to consider in what form gold, copper, and selenium exist in the respective chilled and colourless glasses, and how far they may be looked upon as being in combination, or merely in so fine a state of division that they have no visible effect on light. The chemical and physical evidence that, when they do give colour, they are in the elementary state, seems to be fairly conclusive; but this does not necessarily exclude the possibility of their being in something very like chemical combination in their colourless states.

Perhaps it is needlessly striving after definiteness to attempt to distinguish between bodies being dispersed in an extremely fine state of division, partly at least through chemical attraction for their solvent, and being held in a loose kind of chemical combination. Some consideration of such a question, however, is helpful in suggesting experiments, and some instances may be given. One is in connection with the composition of a glass to give the full possible colour with copper. The notion of something like chemical combination of the copper leads to the study of the effect of varying the relative amounts of the basic and acid ingredients of the glass. More of the basic part, such as the alkalies, might be expected to turn the copper out of combination, and more of the acid part to keep it in. It would be tedious to describe in detail the results of numerous trials with glasses, and the point can be equally well illustrated by simple experiments with borax beads. Copper oxide mixed with about twice its weight of tin oxide, can be dissolved in molten borax in an oxidising flame, and then reduced in a reducing flame. On cooling, the bead is either colourless or "strikes" red according to the concentration of the copper. If colourless it can, with suitable

concentration, be made to "strike by re-heating. Now, if to the bead which "struck" red on cooling, more boric anhydride be added, and the bead again fused, it will remain colourless on cooling; but, unless too much boric anhydride has been added, it will "strike" red on re-heating. Addition now of more alkali, in the form of sodium carbonate, will restore the property of striking red at once on cooling. Similarly it follows that a bead which remains colourless on cooling, but "strikes" on re-heating, can be prevented from giving any colour of copper at all by more boric anhydride, and the property of "striking" red on re-heating can be restored by the further addition of alkali. Of course, in making these various additions of alkali and acid to the bead, there must be a change in the concentration of the copper; but a bead can be got in so sensitive a condition that a mere trace of alkali will determine whether a red colour is developed or not, and a number of experiments on glasses and glazes do confirm the notion of chemical action playing a part on lines which would be expected from general chemical experience.

When manganese dioxide is added to a glass as a so-called decolourising agent, it is intended to be left in an oxidised condition, so as to give a violet colour which will disguise the green colour due to iron, and produce only a slight darkening of a neutral tint, scarcely visible except in thick pieces of the glass. Sometimes the violet tint is overdone, and can easily be seen and sometimes so much of the manganese dioxide has been reduced that the green due to iron is fully visible, the lower oxide of manganese giving no colour to the glass. In many instances of glasses in which one would be inclined, from mere inspection, to say that all the manganese dioxide has been reduced in the furnace, it has been found that a strong violet colour can be developed by exposure to radium or by cathode discharge in vacuum tubes. In parenthesis it may be remarked that potash glasses generally give a good violet and soda glasses a brown, or a brownish violet. Using small amounts of manganese dioxide in batch mixtures, as free as possible from iron, it has been found possible to get glasses practically colourless to the eye, some of which readily give colour on exposure to radium for a period during which others develop no colour. In making the latter, the conditions in the furnace were arranged for complete reduction of the manganese dioxide. In making the former, as little de-oxidation as possible was aimed at. In one instance, thin rods drawn from the melt of one of these, in which very little manganese dioxide was used, cooled almost colourless, but "struck" quite a marked violet colour on re-heating. This chilled glass was also very sensitive to radium. More urgent work prevented further experiments, but the facts so far obtained are mentioned as relevant to the question of the chemical condition of colouring agents in glasses, and as an illustration of one which would appear to be somewhat of a border line example of the groups (*a*) and (*b*) referred to previously. I am reluctant to dismiss the matter in this rather summary fashion, but the interesting speculations which will occur to many can hardly be dealt with shortly. I would, however, recall the well-known pink or violet colour to be seen in some window glasses which have been exposed for years to daylight. In all examples which I have been able to examine, manganese has been found to be present, and I can imagine that the colour has developed in daylight in a manner similar to that in which it has been found to be developable in manganese glasses by radium, by cathode discharge, or by heat. The colour of the old window glasses is a little puzzling, if they are soda-lime glasses One would expect them to be browner in tint; but perhaps on insufficient grounds, since no direct experiments have, so far as I know, been made with manganese glasses made with potash and with soda batch mixtures and exposed to sunlight for a long period. It is a matter for regret that, when the old tinted window glasses were examined for manganese, the idea of the influence on the colour of the alkalies present did not occur. [Having regard to the effect of manganese greatly to enhance the phosphorescence of potash and soda-lime glasses, and to the known colouration of certain potassium and sodium compounds under cathode discharge, it is possible that the colours in the old window glasses described are not due to manganese dioxide itself, but that manganese may have rendered the alkali compounds in the glasses more sensitive to light of short wave lengths. The fact that glasses containing no manganese did not colour under cathode discharge, etc., is not conclusive, since such glasses showed but feeble phosphorescence. The observation, however, that of two glasses containing the same amount of manganese, and giving equal phosphorescence, the one, in which there is evidence of some of the manganese being in the higher state of oxidation, becomes very markedly coloured by

an amount of exposure to rays which has no visible effect on the other glass in which the lower oxide of manganese only is present, seems at least to point to some special behaviour of manganese dioxide.]

The influence of different alkalies and the remarks already made on the effect of varying the relative proportions of bases and acids on the copper glasses, bring me to a short consideration of the behaviour of colouring agents which would generally be placed in group (*b*) as existing in glasses in a state more nearly resembling that of true solution than that which may be considered to obtain in the more colloidal solutions of gold, copper, selenium, and other substances such as silver, sulphur, carbon, etc., with which there has been no time to deal. I must confine my remarks to but few of group (*b*), and perhaps nickel and cobalt will be the most suitable to illustrate the effect of different alkalies and also that of varying proportions of one and the same alkali.

If three similar and moderately soft glasses be made containing respectively potash, soda and lithia as the alkalies present in chemically equivalent proportions, and if the same amount of nickel oxide be present in each glass, marked difference in the colours is observed. The potash glass is a fine deep violet, the soda glass is almost brown with only a hint of purple in the brown, and the lithia glass is a yellowish brown with less strength of colour altogether in it than there is in the soda glass. Similar differences can be seen in beads made from nickel oxide dissolved in the bi-borates of the three alkalies. Of these alkalies, potash is the strongest and lithia the weakest base. The glasses mentioned would not be described as acid glasses, but as glasses containing a fair proportion of basic to acid ingredients. If highly acid glasses be made with the three alkalies and the same proportion of nickel oxide, the lithia glass is only slightly coloured a brownish yellow, the soda glass is a lighter brown with no trace of purple in it, and the potash glass is rather darker in shade than the soda glass, but a definite brown. Again, very similar results can be obtained in beads of the borates of the alkalies by varying the proportions of acid and alkali, and using the same amount of nickel oxide in each set of experiments. With potash as the alkali the proportions of boric anhydride and alkali and the concentration of nickel oxide can readily be adjusted to show a bead coloured brown when cold, but becoming a definite violet when heated just below a dull red heat. A like change of colour has been observed in experimental glasses made for studying the colours obtainable from nickel.

With cobalt oxide as the colouring agent, the difference between the blue colours of potash and soda soft glasses is not very noticeable; but a similar lithia glass is less coloured, and there is an appreciable violet tint in the colour. If, however, using any one of the three alkalies a highly acid glass containing the same amount of cobalt oxide be made, the difference between it and the comparable soft glass is very marked. There is much less depth of colour altogether. What there is is a somewhat violet blue in the case of the potash glass, a rather lighter and more violet blue in the soda glass, and a still lighter pink violet in the lithia glass. This nearly pink glass goes to a weak but quite distinct blue when heated.

The effect of the alkalies potash and soda on the colour of borates is not so marked in the case of cobalt as it is in that of nickel. Lithia in comparison with them always gives for equivalent proportions a much more decided violet tint in the blue. The influence of the proportion of base to acid, however, is marked, and can be very well seen, by using any one of the alkalies in varying proportions with molten boric anhydride, to which a small amount of cobalt oxide (about 0·25 per cent.) has been added. [Cobalt oxide dissolves in highly heated boric anhydride, but on cooling cobalt borate separates out, giving an opaque, very pale blue, glassy mass.] Taking lithium carbonate as the alkali and adding only a very small amount (about 0·25 per cent.) the whole of the cobalt remains in solution on cooling, and the resulting glass is seen to be blue while still hot, to change to a more and more violet tint on cooling, and to be almost a pink when cold. The addition of more of the alkali intensifies the blue colour, giving greater depth of colour, and the mass when cold is a violet blue. Similar variations in colour can be obtained with equivalent quantities of potash and soda, but the effect of these alkalies is always to give a more pronounced blue as the amount of alkali is increased. Comparing the weakest base, lithia, then with potash the strongest, and progressively adding each to borate beads containing cobalt, no amount of lithia, up to the point when it is impossible to keep the bead vitreous, will give as blue and as strongly coloured a bead as the equivalent, or even less than the equivalent, of potash will produce. There is always a more violet tint in the lithia bead.

In conclusion, a brief reference may be made to another colouring agent, copper oxide. This oxide is not soluble in boric anhydride when a bead of the latter is heated in an oxidising flame, but by the addition of an alkali a clear blue bead is obtained. Should the alkali, *e.g.* potash, be added in very small amount, so as to give a highly acid mixture of about the composition, for instance, represented by the portions $K_2O.5OB_2O_3$, the colouration due to about 0·25 per cent of copper oxide is so faint that the bead is practically colourless, although this amount of the oxide is sufficient to give a markedly blue bead in potassium bi-borate, $K_2O.2B_2O_3$. In this case, also, then the colour becomes more intense as the amount of alkali used is increased.

One is tempted to compare this effect of alkali on the copper oxide and boric anhydride mixture with that of water on copper sulphate, which, in the anhydrous state, represented by the formula $CuSO_4$, is white. The addition of water sufficient to give the composition $CuSO_4.H_2O$ leaves the substance still white; but with more water the well-known blue copper sulphate $CuSO_4.5H_2O$ is produced. Without going so far as to call this an example of hydrolysis by water, it may not be too much to speak of the development of colour as indicating in $CuSO_4.5H_2O$ a greater tendency to the formation of blue copper hydroxide than is possible with the smaller mass of water in $CuSO_4.H_2O$.

The notion that there is an analogy here with the progressive development of colour in glasses and borates with increase of alkali may be suggested but with reservations. Still, the changes from brown to violet in the case of nickel, from pink to blue in the case of cobalt, and the progressive development of the colour of copper, all brought about by increasing the proportion of alkali, do seem to point, if not to a definite separation out of the oxides of these metals, to something like it in the sense that with very little of the alkali present the oxides of the metals may be playing a basic part, but are turned out by more of the stronger base (the alkali), and may be either freed or caused to play the part of acids to the alkali. The study of a wide range of colouring agents in glasses has furnished some facts which, from a chemical point of view, lend plausibility to the notion and others which seem to need a great deal of interpretation to support it. As an idea it has been useful in suggesting methods of producing as well as of preventing, colour in glasses. More facts, however, must be accumulated for a fuller and more correct shaping, in its physical and chemical aspects, of one of the many interesting problems connected with glass.

THE CHAIRMAN (Mr. Campbell Swinton), in proposing a hearty vote of thanks to Sir Herbert Jackson for his intensely interesting lecture, said the experiments which had been shown revealing the beautiful colours which were to be obtained by putting gold into solutions and into glass were exceedingly old. He understood that the beautiful colours in the glass that existed in many cathedrals had been produced in that way by the monks in the Middle Ages, although of course they were not as familiar with the chemistry of the subject in those times as the lecturer was at the present day. He was sure the audience would agree that the lecture was worthy to rank with the first Trueman Wood Lecture, which was paying a very high compliment to Sir Herbert Jackson, as the first lecture was of the highest order.

SIR HENRY TRUEMAN WOOD said he desired to avail himself of the privilege of seconding the vote of thanks, firstly, because it gave him the opportunity once more of expressing his deep appreciation of the very high compliment that was paid to him by the Council of the Society a year ago when he resigned the office of Secretary; and, secondly, because he wished to express his gratification that the series of lectures, which was so well inaugurated by the masterly exposition given by Sir Dugald Clerk of the principles of the application of science to industry, had been carried on by the admirable discourse which Sir Herbert Jackson had delivered, illustrating the problems which arose in trying to apply scientific improvements to the details of one particular industry. It was a great pleasure to him that the lecture should have been given by his old friend Sir Herbert Jackson, who first appeared before the Society thirty-five years ago, as assistant to Professor Thomson, then Professor of Chemistry at King's College, in the excellent lecture Professor Thomson gave on Crystallisation. Since that time he had rendered many services to the Society, and had frequently taken part in its proceedings. He had heard Sir Herbert lecture on various occasions, but he had never heard him speak more effectively or illustrate his remarks better. He hoped that future lecturers would continue the course which had been so well begun, and that the lectureship would be not only a credit to the Society but also a help to British industries.

The resolution of thanks was then put and carried, and, SIR HERBERT JACKSON having briefly acknowledged the compliment, the meeting terminated.

OBITUARY.

ALEXANDER IZAT, C.I.E., M.INST.C.E. — Mr. Alexander Izat, the well-known Indian railway engineer, died at his Scottish residence, Ballilesk, Dollar, on January 2nd, at the age of seventy-five. He commenced his long career in 1863 as a young assistant in the Public Works Department, and retired after nearly thirty years' very active service with the reputation of having initiated and carried out larger additions to the Indian railway system than any other single individual. In 1883 he was "lent" by the Government to the Bengal and North-Western Railway as Agent and Chief Engineer, and after his retirement he became successively managing director and chairman of the Company. He resigned the chairmanship twelve months ago, but retained his seat on the board of directors. He was also a director of several other important Indian companies. His Companionship of the Indian Empire was conferred in 1898. Mr. Izat joined the Royal Society of Arts as far back as 1881.

GENERAL NOTE.

OSCILLATIONS OF A HIGH CHIMNEY. — The *Engineer* draws attention to the investigations conducted by Professor Omori into the movements of the top of a high chimney when subjected to wind pressure. The chimney observed is built of reinforced concrete, 570 ft. high, and 26 ft. 3 in. inside diameter at the top, and is situated at Saganoseki. Wind velocities were recorded ranging from less than one mile per hour to a hurricane velocity of 78 miles. The amplitude of vibration at a velocity of 50 miles per hour was less than one inch, while at 78 miles per hour it was 7·32 inches. The maximum amplitude was in a direction at right angles to that of the wind. Professor Omori thinks that with wind gusts of 110 miles an hour, which occasionally occur in Japan, the amplitude would be at least 15 inches. The period of vibration was nearly constant for all velocities, varying only from 2·52 to 2·56 seconds.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

JANUARY 21.—ALFRED H. POWELL, "Ancient Cottages and Modern Requirements." The Right Hon. EARL FERRERS will preside.

JANUARY 28.—SIR CECIL HERTSLET, late H.B.M. Consul-General for Belgium, "The Ruin and Restoration of Belgium." EMILE CAMMAERTS will preside.

FEBRUARY 4.—ALFRED E. HAYES, General Secretary, English Language Union, "The English Language and International Trade."

FEBRUARY 11.—LIEUT.-COMMANDER NORMAN WILKINSON, R.N.V.R., O.B.E., R.O.I., R.I., "Naval Camouflage."

FEBRUARY 18. — SIDNEY PRESTON, C.I.E., "English Canals and Inland Waterways." NEVILLE CHAMBERLAIN, M.P., will preside.

FEBRUARY 25. — JAMES CURRIE, C.M.G., Ministry of Labour (Training Department), late Principal, Gordon Memorial College, Khartoum, "Industrial Training."

MARCH 3.—WILLIAM JAMES GARNETT, First Secretary, H.B.M. Diplomatic Service, "Mongolia from the Commercial Point of View."

MARCH 10.—H. M. THORNTON, "Gas in relation to Industry and Housing."

Dates to be hereafter announced :—

AIR-COMMODORE EDWARD MAITLAND, C.M.G., D.S.O., "The Commercial Future of Airships."

BRIGADIER-GENERAL SIR HENRY P. MAYBURY, K.C.M.G., C.B., M.Inst.C.E., "Road Transport."

CHARLES H. SHERRILL, "Stained Glass."

LADY INGLEFIELD, President, Buckinghamshire Lace Association (North Bucks and Bedfordshire), "The Hand-made Lace Industry."

GRAILY HEWITT, "Rolls of Honour."

CHARLES CROWTHER, "The Arts and Crafts of Japan" (with examples from the author's private collection).

WILLIAM CRAMP, D.Sc., M.I.E.E., "Pneumatic Convoying Plants, with special reference to the Transport of Grain."

L. GASTER, "Industrial Lighting in its relation to Efficiency."

BRIGADIER-GENERAL LORD MONTAGU OF BEAULIEU, C.S.I., "Roads and Transport in India."

SIR GEORGE CUNNINGHAM BUCHANAN, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

SIR VALENTINE CHIROL, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

SIR FRANCIS WATTS, K.C.M.G., D.Sc., Imperial Commissioner of Agriculture for the West Indies, "Tropical Departments of Agriculture, with special reference to the West Indies." LIEUT.-COLONEL SIR DAVID PRAIN, C.M.G., C.I.E., LL.D., F.R.S., Director of the Royal Botanic Gardens, Kew, will preside.

G. F. SCOTT ELLIOT, M.A., B.Sc., F.R.G.S., "Trade Routes for the Empire in Africa."

PROFESSOR WILLIAM A. BONE, D.Sc., Ph.D., F.R.S., "Lignite."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m :—

February 19, March 18, April 15, May 20.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—
February 3, March 2, May 4.

CANTOR LECTURES.

Monday evenings, at 8 p.m.:—

CAPTAIN H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S., Fellow of Downing College, Cambridge, and formerly of the Royal Air Force, "Aircraft Photography in War and Peace." Three Lectures.

Syllabus.

LECTURE I.—JANUARY 19.—The taking and production of aerial photographs—Development of the aeroplane camera during the war—Type of photographs obtained—Dark-room work.

CHARLES FREDERICK CROSS, B.Sc., F.R.S., F.C.S., "Recent Research in Cellulose Industry." Three Lectures.

February 16, 23, March 1.

WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.

May 3, 10, 17.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 19...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Captain H. H. Thomas, "Aircraft Photography in War and Peace." (Lecture I.)

Post Office Engineers' Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.30 p.m.

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Dr. A. T. Schofield, "The Psychology of the Female Mind."

East India Association, 7A, Tothill-street, Westminster, S.W., 3.45 p.m. Miss F. R. Scatcherd, "India and her Friends: Wise and Otherwise."

Surveyors' Institution, 12, Great George-street, S.W., 7 p.m. (Junior Meeting.) Mr. R. E. A. Dash, "The Housing Question and how it is affected by Recent Regulations."

Geographical Society, 135, New Bond-street, W., 8.30 p.m. Colonel J. Tilho, "Tibesti to Darfur."

TUESDAY, JANUARY 20...Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.30 p.m. Mr. H. Moore, "Spontaneous Ignition Temperatures of Liquid Fuels."

Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m. Mr. G. H. Knibbs, "The Organisation of Imperial Statistics."

Royal Institution, Albemarle-street, W., 3 p.m. Sir John Cadman, "The Modern Development of the Miner's Safety Lamp."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. T. H. B. Scott, "Pictorial Suggestions."

Mineralogical Society, at the Geological Society, Burlington House, W., 5.30 p.m.

Metals, Institute of (Birmingham Local Section), Chamber of Commerce Buildings, New-street, Birmingham, 7.30 p.m. Dr. W. H. Hatfield, "Season Cracking."

WEDNESDAY, JANUARY 21...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. A. H. Powell, "Ancient Cottages and Modern Requirements."

Aëronautical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m.

Meteorological Society, at the Royal Astronomical Society, Burlington House, W., 5 p.m. Sir Napier Shaw, "Pioneers in the Science of Weather."

Geological Society, Burlington House, W., 5.30 p.m.

Japan Society, 20, Hanover-square, W., 4.30 p.m. Major J. J. O'Brien Sexton, "Colour Prints of Harunobu and others."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5 p.m. Dr. J. W. Mackail, "Collins; and the English Lyric in the Eighteenth Century."

THURSDAY, JANUARY 22...Royal Society, Burlington House, W., 3.30 p.m. Special General Meeting, 4.30 p.m. 1. Professor E. G. Coker and Mr. K. C. Chakko, "The Stress-Strain Properties of Nitro-Cellulose and the Law of its Optical Behaviour." 2. Mr. S. Marsh, "On Alternating Current Electrolysis." Communicated by Professor E. H. Griffiths, F.R.S. 3. Dr. W. H. Eccles and Mr. J. H. Vincent, "The Variations of Wave-Length of the Oscillations Generated by Three Electrode Thermionic Tube due to Changes in Filament Current, Plate Voltage, Grid Voltage or Coupling." 4. Mr. S. D. Carothers, "Plane Strain. The Direct Determination of Stress." 5. Mr. F. Horton and Ann C. Davies, "An Investigation of the Effects of Electron Collisions with Platinum and with Hydrogen, to ascertain whether the Production of Ionisation from Platinum is due to Occluded Hydrogen." 6. Messrs. L. Bairstow, R. H. Fowler and D. R. Hartree, "The Pressure Distribution on the Head of a Shell moving at High Velocities."

Dyers and Colourists, Society of (West Riding Section), Dr. F. M. Perkin, "The Application of Electricity in the Dyeing Industry."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. R. R. Terry, "Renaissance Music in Italy and England." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Sir Alexander Kennedy, "The War Area from Ypres to Verdun."

Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Mr. J. L. Thompson, "Transformers for Electric Furnaces."

Numismatic Society, 22, Albemarle-street, W., 6 p.m.

Mining and Metallurgy, at the Geological Society, Burlington House, W., 5.30 p.m.

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 7.30 p.m. Dr. J. S. Owens, "The Attrition of Concrete Surfaces Exposed to Sea Action."

FRIDAY, JANUARY 23...Royal Institution, Albemarle-street, W., 9 p.m. Sir Charles Parsons, "Researches at High Pressures and Temperatures."

Metals, Institute of (Sheffield Local Section), The University, Sheffield, 7.30 p.m. Mr. J. A. Morton, "Defects (and their Causes) in the Manufacture of Spoon and Fork Blanks."

University of London, University College, Gower-street, W.C., 5 p.m. Dr. T. Borenius, "Mediæval Art." (Lecture II.)

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

Mechanical Engineers, Institution of, Storey's-gate, Westminster, S.W., 6 p.m. Mr. E. M. Bergstrom, "Recent Advances in Utilization of Water Power."

SATURDAY, JANUARY 24...Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. Noyes, "Aspects of Modern Poetry." (Lecture II.)

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FRIDAY, JANUARY 23, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, JANUARY 26th, at 8 p.m. (Cantor Lecture.) CAPTAIN H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S., Fellow of Downing College, Cambridge, and formerly of the Royal Air Force, "Aircraft Photography in War and Peace." (Lecture II.)

WEDNESDAY, JANUARY 28th, at 4.30 p.m. (Ordinary Meeting.) SIR CECIL HERTSLET, late H.B.M. Consul-General for Belgium, "The Ruin and Restoration of Belgium." EMILE CAMMAERTS will preside. The paper will be illustrated with lantern views.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, January 19th, LIEUT.-COLONEL ALLAN J. C. CUNNINGHAM in the chair, CAPTAIN H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S., Fellow of Downing College, Cambridge, delivered the first lecture of his course on "Aircraft Photography in War and Peace."

The lectures will be published in the *Journal* during the summer recess.

SIXTH ORDINARY MEETING.

WEDNESDAY, JANUARY 21st, 1920; The Right Hon. EARL FERRERS in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Adams, Sidney James, London.
Arthur, Major Edmond John, Birmingham.
Ashworth, Arthur, Bury.
Calvert, Alderman Joseph, J.P., Middlesbrough.
Clifford, William John, Brockenhurst, Hants.
Colwyn, Right Hon. Lord, Colwyn Bay.
Croft, Cyril Murton, London.
De Cruez, J. A., London.
Dickinson, Mrs. M., Brighton.
Evans, Joseph S., Commander, U.S. Navy, Washington, D.C., U.S.A.
Froud, Edgar Arnold, London.
Ghatalah, M. H. P., Banganapalle, India.
Goslin, James, Johannesburg, S. Africa.
Greenshields, J. N., K.C., Montreal, Canada.
Griggs, Arthur Robert, Bromley, Kent.
Hart, George Eaton, London.
Hendry, Brigadier-General Patrick W., C.B., Glasgow.
Kelsey, William K., B.A., London.
Knowlton, Elliot Ainsworth, Rochester, U.S.A.
Lawrence, John Edward, London.
Longden, Major Alfred Appleby, D.S.O., London.
Mermoz, Francisco Alberto, Buenos Aires.
Mitchell, John, London.
Mitchell, John M., M.I.Mar.E., Sydney, N.S.W., Australia.
Morrell, Clayton Conyers, London.
Morris, Arthur Percy, B.Sc., Assoc.M.Inst.C.E., Burma.
New Jersey, The Right Rev. Bishop of, Princeton, New Jersey, U.S.A.
Palmer, Austin Norman, New York City, U.S.A.
Penicud, John William, Paris.
Pettigrew, J. Stewart, Glasgow.
Redgate, C., Heanor, Derbyshire.
Rhodes, John Edwin, M.D., Chicago, Illinois, U.S.A.
Sayner, George Smith, Richmond, Surrey.
Shay, Peter Yevent, B.Sc., Sheffield.
Silverman, Professor Alexander, Pittsburgh, Pa., U.S.A.
Spear, William, Edgware, Middlesex.
Stanfield, George John, Carlisle.
Sutherland, Charles H., Nova Scotia, Canada.
Taft, William Howard, LL.D., D.C.L. (Ex-President of the United States), New Haven, Conn., U.S.A.
Tattersall, John, Enschede, Holland.
Vaus, Frank H., London.
Thomson, George Clark, Saskatchewan, Canada.
Walsh, Lawrence J., Southbridge, Mass., U.S.A.
Willis, James Harold, B.Sc., Cardiff.
Woodhouse, William H., Crewe.
Wright, Lieut.-Colonel Clifton Vincent Reynolds, London.

The following candidates were balloted for and duly elected Fellows of the Society:—

Bassett, Frank Owen, London.
Bassett, John Harrold, London.
Clark, Victor Albert Jarvis, London.
Gaunt, Frederick William, Farsley, near Leeds.
Haas, Adolph Louis, A.M.I.Mech.E., London.
Hainsworth, Charles, Farsley, near Leeds.
Hargreaves, Miss Violet, Eccleshall, Staffs.
Holmes, H., Moseley, Birmingham.
Ibbotson, Walter Dudley Boswell, Bowdon, Cheshire.
Kay, Max M., Manchester.
Maurice, Ernest Maurice, London.
Russell, Captain Guy, London.
Salmon, Harry, West Hartlepool.
Smith, John, M.I.Mech.E., Edgbaston, Birmingham.
Turner, Augustus, M.A., London.
Waite, David E., Palmer, Mass., U.S.A.
Whittaker, Cecil John, Sunderland.
Wilding, John, Shotton, Flint.

A paper on "Ancient Cottages and Modern Requirements" was read by Mr. ALFRED H. POWELL.

The paper and discussion will be published in the next number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Friday, January 2nd, 1920; SIR HARVEY ADAMSON, K.C.S.I., M.A., LL.D., Lieutenant-Governor of Burma, 1910–15, in the chair.

The paper read was—

BURMESE VILLAGE INDUSTRIES: THEIR PRESENT STATE AND POSSIBLE DEVELOPMENT.

By A. P. MORRIS, B.Sc., Assoc.M.Inst.C.E.,
Provincial Art Officer, Burma.

The subject of this paper is "Burmese Village Industries: their Present State and Possible Development." It might perhaps have been better had I chosen the word handicrafts instead of industries, since I do not include the greatest of all the village industries—agriculture; but I gather that the exclusion will be understood.

Our Burmese village industries cover a wide variety of crafts. The members of the Indian Industrial Commission who paid us a visit in January, 1918, were struck with the high grade of the craftsmanship, and in the course of their report they say: "The small indigenous industries present several features widely differentiating them in character and organisation from the corresponding industries in India. Considering the size of the industries themselves and the number of persons engaged in them, a relatively large proportion of the articles produced appear likely to command a sale in other parts of the world."

This notwithstanding, the village craftsman is generally poor, poorer than his agricultural brother. This is not due to laziness, as some suppose; the craftsman, take him all the year round, works harder and for longer hours than the agriculturist. But the result of this poor return for skilled work is that there is a gradual defection from the ranks of the craftsmen, the crafts are dying, and the men are not passing to other more remunerative crafts, but to the production of raw materials.

Now, if agriculture and the production of raw materials give better returns to the people, is it worth while worrying about these moribund handicrafts? It would perhaps require a great deal of detailed argument to prove definitely that the decay of handicrafts is bad for any country. It is possibly true of some of the Burmese village industries that it would be better to let them die a rapid natural death, rather than by artificial means to continue them in a state of senile decrepitude. But if I can show that some village industries are desirable, that in some cases the causes which have weakened the industries can be excised and removed by suitable treatment; that certain industries have already been improved by aid of a kind that cannot be called mere benevolent bolstering, then I shall have gone some way to establishing a case for the consideration of schemes for developing the Burmese village industries.

It is manifestly impossible for me to deal with each industry in detail, and I must to some extent classify and generalise, illustrating my points by references to particular industries. For the sake of convenience I have grouped the industries under three heads. (1) Supplementary industries. (2) Whole-time industries, which I would subdivide into (*a*) art industries; (*b*) quantity production industries. (3) Trades. These are arbitrary classifications, they overlap, and some industries might be included in more than one of the groups.

In a note on the development of village industries in the Delta, a recent Commissioner of Bassein says: "I take it that one of the chief causes of crime in this division is the fact that it is a one-crop area (paddy) in which one-yoke cultivators can hardly make ends meet.

They urgently need subsidiary crops or industries to eke out a living. Further, subsidiary industries would, while improving the economic conditions, keep agricultural labourers employed throughout the months when agricultural employment cannot be got. There is no definite prospect of subsidiary crops, and it is therefore most necessary to develop cottage industries, and I think this Division has much to hope for from a careful consideration of its economic conditions by the Indian Industrial Commission." Here, then, is a case where some industries are desirable.

Now it is not possible to make all industries supplementary industries. To be suitable for this purpose an industry should be fairly easy to learn, it should be possible to carry it on at odd times and for irregular periods, and it should not need much outlay for apparatus. This considerably limits the field.

Some of the most suitable industries for the purpose are the various forms of weaving, whether with silk into piece-goods, or of grass, cane, reed, bamboo, or other materials into matting and baskets. These different forms of weaving are practised in the Province, and they are capable of very valuable extensions.

In silk weaving we have an industry which has an assured outlet for its products. The Burmese, men and women alike, wear silk for their holiday attire, and the demand for silk goods is very considerable. The import of silk yarn into Burma from China is valued at 26 lakhs annually, and in addition there is a large import of silk piece-goods. Yet the silk-weaving industry was dying until, on the advice of Mr. Saunders, of the Indian Civil Service, the Local Government secured the services of a weaving expert and started a small school at Amarapura, one of the most important silk-weaving areas in Upper Burma. The school does not aim at instructing novices, but takes villagers already trained in the use of their own looms and gives them instruction in the use of a different type of loom, changing them over from the hand thrown to the mechanically thrown shuttle. This, together with the other instruction given in the school, has so improved the rate of output, without destroying the characteristics of the industry as a cottage industry, that the villagers can now make quite a reasonable profit. By the formation of co-operative credit societies of weavers, the financing of the trained craftsman has been facilitated and the industry is regaining lost ground. Experiments are also being undertaken to determine whether silk can be grown on a large scale in the Shan States. It is too early to give a definite answer to this question, but it seems likely that the experiment will succeed, and if so this will do a great deal to ensure the success of the industry.

The disadvantage of the centralisation of instruction in a weaving institute is one inherent in all attempts to foster a subsidiary industry which will engage a large number of workers whose homes are spread throughout the country instead of being concentrated in a small area. While it is not difficult to get people from near by to attend the school, the villagers will not readily go to the other end of the Province to learn a trade, and the school at Amarapura does not easily attract people from a long distance. The educational work must be begun from some point, and it is necessary to have an establishment under the control of a really highly qualified expert, both to initiate the training, and to test the possibility of establishing an industry. But once it is found that the industry can be made to pay its way, the Central Institute is not enough. This is true perhaps of all technical education, but in the higher grades a single institute can, and on account of expense must, suffice for a large area, but in a lower grade of technical training you cannot expect the pupils to go far, your radius of efficiency decreases, and you must take your education to the pupils. This means that either the Central Institute must be itinerant, moving from one centre to another and only staying in each area long enough to establish the industry, or the Central Institute must be made a training-ground for instructors, and these instructors can then be sent out into the villages to establish training in the schools. This is perhaps more practicable, but it is necessary for the expert to supervise carefully the work of these instructors, and not to leave supervision to the ordinary schoolmaster, for there is always some danger of the training, under less expert instructors, falling to a lower standard.

But by supplying a supplementary industry for a large number of workers the output will probably rise beyond the local demands, and we then have to meet the question of marketing. This necessitates organisation of a type more advanced than mere co-operative loan societies, and in this respect the work done by the American Education Department in the Philippines is worth quoting. My source of information is a periodical published in the Philippines; I obtained a few numbers in Burma, and while the outline now given is incomplete from the

nature of my references, it gives some idea of the general scheme. The problem seems to have been somewhat similar to ours—the need of subsidiary industries, and one of those taken up was mat and basket work. Roughly speaking, the method is to give instruction in the schools taking an industry as part of the curriculum. By the time the pupils leave school they have in their hands a possible subsidiary industry. On the industrial side the organisation is carried on by bureaux which, on the one hand keep traders informed of the products available, and if necessary act as agents, and on the other hand supply the schools with ideas for new developments of the industry. The schools are the centres for testing new ideas, and the bureaux pass on the results of successful experiments from one area to another. It needs intelligent co-operation between the bureaux and the educational authorities, but that is only a matter of efficient organisation.

So far in Burma, except for recent work on silk weaving, we have not been very successful with education in subsidiary industries. There have been spasmodic attempts to develop industries; lack of really expert instruction, disregard of the economic problems involved, attempts to make income out of instruction, and other causes, have been at the base of the failures. Perhaps the most promising attempt was that made in the Roman Catholic mission school at Thonze, where some excellent mat and basket weaving was done, but the course was crowded out by the demands of the official school curriculum.

In Burma we have an abundance of excellent mat and basket material, and I believe that, if the complete organisation which I have outlined were instituted, we could do much to keep the Delta supplied with subsidiary industries. But it must be a complete organisation. You cannot do the education alone and leave the marketing to private enterprise, certainly not for the first years of the industry. The little trader is not an economical collector or distributor, and he cannot pay the craftsman a reasonable wage; he absorbs too much himself. On the other hand a large firm is not likely to take up the work; it has too much of the nature of an experiment about it. It seems to me that this is just one of those cases where experiment is justified and necessary. Like all experimental work it will be something of a gamble, but a reasonable balance of successes may be expected.

The Weaving Institute has dealt only with adults in a whole time course. Personally, for the establishment of a subsidiary industry, or indeed for any industry, I would favour a slower course with younger people. Here again I would instance the work in the Philippines, and I quote verbatim from a book by Dean C. Worcester, who was from 1900 to 1913 Secretary to the Interior in the Philippines: "Previous to 1909 industrial education was only partially organised. Experience had shown by that time that it was expedient to introduce a degree of specialisation into the course of study at an early stage of the child's development. Special intermediate courses were, therefore, organised to meet the need. After finishing the four years' primary course the child may choose between a course of teaching, a course of farming, a trade course, a course in house-keeping and household arts, and a general intermediate course. Relatively few children are at present able to take up secondary courses, and it is therefore necessary to provide in the lower grades for instruction which will prepare them for some vocation. So important has become this line of instruction, that it has been found necessary to maintain in the general office an industrial information department." Again the same writer, quoting from an official report, says that out of 235,740 boys and 138,842 girls, 216,290 boys and 125,203 girls are taking some form of industrial work; of this number 30,000 are engaged on hat making, 40,000 are making mats, and 104,000 are doing basketry. Apparently from the figures some children learn more than one industry.

Now apply that to Burma. Apart from the Anglo-vernacular schools we have a very extensive vernacular educational system based on a ten years' course, but as a matter of fact very few of the pupils go beyond the fifth year. The education given is purely literary, except for a very small amount of "hand and eye" training. It is good in its way, but unless the student goes on to the tenth year it really does not lead to much, it fails to establish anything. It is on this course that I would suggest that we should graft, as the American Educational Department has done, some form of vocational training in subsidiary industries. It need not in any way lower the value of the intellectual training—quite the contrary; but it will leave the pupils better equipped for life.

There is one danger about craft-training which needs careful watching, and that is the attempt in such instruction to teach pupils to run before they can walk, and to make things before processes have been thoroughly learned. This desire is often fostered by poverty, by

lack of funds in the school, for then there is a tendency to attempt to make income out of instruction. This is fatal to good instruction, and no finished product should be made beyond what may be necessary to stimulate interest, unless the pupil has first thoroughly mastered the necessary skill. But I certainly prefer to give craft-training as an extension of schooling, to work on material still amenable to school discipline, rather than to work on the adult with set ideas. The child learns new processes more readily, and is not so anxious to get away to make money before the instruction is complete.

I now turn to my second group, the Art Industries. The Burmese as a people have a natural talent for art, they have a keen sense of colour, and considerable decorative ability. To make matters clear I must attempt to sketch in as quickly as possible the position of these industries. Under the term art industries I include all the work in silver and other precious metals, ornamental work in the base metals, bronzes, carving in wood, ivory carving, and all work, in fact, in which the main characteristic is beauty rather than utility. Apart from the question of beauty, the characteristics of these art industries are that the workers are whole-time workers, and from the nature of their work they are comparatively few and isolated.

Under the Burmese *régime*, the possession of vessels of gold and silver was limited by sumptuary laws; the craftsmen, as in Mediæval Europe, lived on the patronage of the Court, and whilst the payment of their dues was probably erratic, it is likely that they did fairly well. The woodcarvers had ample demand for their skill in the decoration of religious structures, and generally speaking the art workers found plenty of scope for their abilities. To-day, instead of a Court with its glittering throng, we have a crowd of clerks toiling in a Secretariat. The Secretariat *quâ* Secretariat can scarcely be regarded as a patron of the arts, but on the other hand the sumptuary laws have been repealed and all who can purchase art wares may do so. The woodcarving industry has suffered from the changed times, there is no longer any great demand for the beautiful carving so abundant on the old structures. With the rising price of timber, and the introduction of a variety of new structural materials, wood is going out of fashion. The times and the fashions are changing, and if the art industries are to revive they, too, must change. Some say that we must preserve the old arts; the craftsmen, according to them, must study the work of their forefathers, and not depart from it. Now, of course, the study of the best in ancient craftsmanship is necessary and inspiring; but the old artists whose work these people admire were experimentalists, and for every masterpiece which has survived, many less successful experiments have been forgotten. A change there must be, for art which is not experimental—which does not create—ceases to be art, it becomes mere imitation, it stagnates, it dies. A change there must be, for the conditions and the demands have changed, the old designs and articles are not wanted, and sad though it may be, an art industry which does not provide bread and butter is not likely to attract recruits, and it will disappear. But if there is any vitality in an industry it should move forward of its own accord and keep pace with the times, and so these art industries might have done had the said changes been normal developments, had the pace not been forced. Things being as they are, some external help is necessary, and it becomes a question how much help can be given, and what should be the nature of that help.

I can best justify such suggestions as I have to make by reference to what has been done. We have in Rangoon an annual art handicrafts exhibition, the establishment of which was, I think, chiefly due to Mr. Tilley, some time Commissioner in Burma. The silversmiths had been accustomed to make figures in silver, these figures being conventional but gracefully shaped. Mr. Tilley suggested to some of the craftsmen that they might turn their hands to bronzes. The first attempts were stiff and formal, with little to commend them, but Mr. Tilley introduced into the exhibitions a regular system of competitions for this work, and helped the craftsmen by criticism and advice, not attempting to design, but pointing out to them where they failed. And now we have an established industry in these bronze statuettes, and the best among them would attract attention anywhere. Now this was a new departure, and the factors which made for success were, first of all, that the suggested work was within the ability of the craftsmen; secondly, they were able to appreciate the idea; and, thirdly, there was a ready market to encourage attempts.

Now let us take the woodcarving industry. The old woodcarving was practically all of it done in connection with architecture; it was applied as ornament on religious structures, and in itself was not part of the structure—it had

to bear no strains. As ornament of this kind it was bold and not very finished, and sufficient relief was supplied by the unornamented spaces. But, as I have stated, this industry is failing, the demand for architectural woodwork is decreasing. In this case the industry must find some new outlet, and well-wishers have suggested all sorts of things for the woodcarver to make, chiefly articles of European furniture. He has, for instance, been called on to make a chair. But he has no use for a chair himself, he does not understand the features which must be studied in the design of European furniture, and he consequently regards the chair merely as something on which to exercise his skill as a woodcarver. And the result is a prickly monstrosity, which is inelegant, uncomfortable, and unsafe. It is not the fault of the craftsman, it is that he has been induced to venture beyond his powers of appreciation, or rather, beyond his powers without some further information and training: training not only in the old traditions of woodcarving design, but in the use of new timbers suitable for interiors, in more accurate joinery, if the work is to come under closer inspection than that to which it has been accustomed as architectural ornament, and training also in the design of new articles.

As a third example, I take the black pottery industry. The black pottery process, or, to be accurate, the blackened earthenware process, is not confined to Burma. This type of ware is made in India and other places. But it reaches a high grade in Burma, and the ware has a very attractive texture. The industry is not exactly an art industry in respect of its main product at present, but recently the potters have turned their hands to the production of ornamental wares, and the annual art exhibition has done much to bring them to popular attention, while we have also been able to help the potters by sending their wares to other sales, thus securing publicity. The potters had of their own initiative attempted to ornament the pottery by producing designs on the surface partly in matt and partly in glossy black, but they were hardly distinct enough to be attractive. A little research work was put in hand at Insein, and a process was discovered which gives the potters a means of making a very attractive red figured black ware. Here a process has been put in the hands of the potters, one which they can readily use, but the design of the pattern has been left to them. The process will enable them to produce an art ware which can be sure of a ready sale at good prices. There is sufficient evidence already for us to be confident of that, and the potters will be considerably benefited by the new outlet for their abilities.

These are instances of what has been done, and they seem to me to indicate what can be done to help the potters. In the first case the problem was comparatively simple and success was soon achieved; in the second case the problem was more difficult and no great success can be recorded as yet, though there is room for hope; in the third case a new process has been placed at the disposal of the craftsmen, and they have already shown their ability to profit by it. I think we can say that the lines indicated are:—

(1) To assist the art workers to obtain a better market by bringing them in touch with purchasers.

(2) To help them in their processes by improving their tools.

(3) To give them new suggestions, provided that these suggestions do not go beyond their scope and comprehension, and when necessary to give them advice on, and to help them to overcome, difficulties in following the suggestions.

All this is on the technical and financial side. If the arts are to retain their national characteristics, the peculiar genius of the race, as they should do, I would advance very cautiously in the matter of design, indeed, I am personally doubtful whether anything much can be done. Certainly not till educated Burmans turn their attention to the art crafts, and towards this there is as yet little evidence of movement. Of course, when the new article is for European use, such as a chair or the silver back of a brush, the general outline must follow lines new to the craftsman, but in this case all detail ornament can and should be left to him. And success can only be expected if the craftsman thoroughly understands the use of the article; for he must, perhaps unconsciously but not the less surely, be guided in his own design by all that has led to the evolution of the shape of the article.

In this the annual Art Exhibition for the Province, especially if it is supplemented as it should be by district exhibitions, is most helpful. The Committees, by the subjects set in the competitions, can help forward the industries, and the craftsmen in competing learn what can be done, and see for themselves, by comparison with their competitors' work, what lines of development are most successful. The exhibitions are also useful on the financial side, for they give the little isolated craftsman a chance to

market his wares, often pretty well his only chance of securing a wide and appreciative market.

I am, however, inclined to think that we might improve on this, and give these art workers an opportunity of selling their products by setting up a sale society in Rangoon. Even now I get a good deal of correspondence from private individuals asking for art materials, and I place out these orders as best I can, but I have not the staff or the time to attend to them efficiently. A sale society in Rangoon, run on a sale-commission basis, need not be run at a loss, and it would be a great gain to the art craftsman. The commission charged should pay the running costs and, according to the relative cost of sales, the rate of commission should from time to time be adjusted.

One word as regards the training of the young art craftsman. The system at present is one of apprenticeship. Youths, often, but not necessarily, the sons of the craftsmen, are taken on and trained, and in course of time they grow up into craftsmen. Government has a small scheme of scholarships which are placed in the gift of the Provincial Art Officer, and he is thus able to encourage some of the leading master craftsmen to pass on their knowledge to the rising generation, and to help the rising generation to study the crafts. But in such an industry as woodcarving where a real change is necessary, this does not effect much good, and I am of opinion that we need a small school of art industries where these art crafts can be studied and better technical methods introduced. In such a school the art instructors should be selected from the Burmese master craftsmen, but of necessity this instruction must be supplemented on the purely technical side by one or two instructors trained in modern methods, and these should in their own lines be master craftsmen too, but not necessarily, in fact preferably not, art craftsmen. A good cabinet-maker and a smith would possibly be all that is required. As a matter of fact, we have done something of the sort in the Government Engineering School at Insein. We have two of the best master craftsmen in Burma, a woodcarver and a bronze worker, resident at the school. These men work for themselves, but they have the young Government apprentices in these crafts placed under them. In addition, these young apprentices spend some time in the school shops where, under the eyes of the technical instructor, a Scotsman of high skill and strict discipline, they learn something of good workmanship. One boy, a young woodcarver, is doing very well, and his elder brother has taken a course of cabinet-making under the same instructor and is turning out a first-class worker. The two have made up their minds that when their training is finished they will set up jointly as manufacturers of furniture, and their joint skill should produce some interesting results.

As a second sub-division of the whole-time industries, there are those industries which I have classified as quantity production industries. Here the artistic element may or may not be present, but the chief characteristics of the group are that large quantities of similar articles are produced and the number of workers is far greater than in a high-class art industry. Speaking generally, these industries are localised in areas, a village, or small group of villages, having the industry as its chief occupation and supplying the needs of a wide area or possibly the whole province; the workers exhibit great ability, but their tools are primitive; the popular demands are in many cases tending to change more rapidly than the products of the industries; and the craftsmen are as a whole miserably poor. It is especially difficult to generalise about this group, and I will take one particular industry first, and then, if I may, illustrate some of the points from other industries.

I take as the typical industry that of the lacquer workers. There are two main centres of production, Pagan, on the Irrawaddy, and an area in the Chindwin District. The chief raw material, the material which is used in preparing the lacquered surface, is known as *thitsi*; it is not found in the area where the industry is carried on, but is imported from comparatively distant parts of the Province. The other materials are bamboo and a few pigments. At Pagan there are some 1,500 people constantly employed in the work, while there are many more engaged as a part-time occupation in weaving the bamboo frameworks to which the lacquer material is applied. The bulk of the wares are crude articles of domestic use, boxes, trays, and bowls, but the highest skilled workers carry the industry up to the level of an art industry. Practically the whole of the output is sold within the Province, only some of the more expensive art wares, and an inconsiderable quantity of the other wares, find purchasers among the European population, and only a very small amount is exported. The cruder wares now have to face the competition of imported enamelled iron and other

articles, and this has prevented a rise in price for local lacquer wares to meet the increased cost of living. There has also been of late years a considerable and growing import of Japanese lacquered wares, which are finding a ready sale among the Burmese, and these wares are made from a material exactly the same as the Burmese wares so far as the lacquered surface is concerned. I estimate that, speaking roughly, the value of the annual output of Pagan, the amount paid to the craftsmen for their wares, is about six lakhs, and the value of the same wares as retailed is not less than 20 lakhs. The craftsmen work independently or in family groups, purchasing their materials in small quantities, and in some cases, as already mentioned, purchasing the made-up frameworks of the articles. The poor income they make renders them unable to accumulate stocks, and as a general rule they live on advances from traders and sell their wares at the traders' prices.

Now these craftsmen, like all craftsmen, are very conservative, and they do not change their methods and products readily. I do not mean that they are incapable of progress. I could show you that in this industry with which I am dealing there have been changes in the last fifty years, changes which have been introduced by the craftsmen themselves. But the social conditions of the Province have been pushed forward centuries in as many decades, and with this change has come a change in the popular demand for materials. This change has been forced from without, and the craftsmen, left without a commensurate external stimulus, have only gone forward at a normal rate of growth. The crude wares which satisfied the customers of their forefathers do not now attract much popular attention, and they have to sell their wares in an indifferent market, which takes them only at a low price.

Last year a few experiments were made in the manufacture of other articles, and it was shown that some of these would find a ready market at prices which would give a much greater remuneration to the craftsmen. Such work needs to be carried further. The crude wares do not give and are not likely to give adequate remuneration, but the whole of the *thitsi* which the Province produces can be quite well deflected to the manufacture of more remunerative lacquered articles, and if this is done the master craftsmen will still be able to continue their industry as an art industry. It is not a question of high research in distant laboratories, for though the work in the laboratories may be useful, what is far more necessary is patient research in the industrial villages working step by step with the craftsmen in the improvement of processes, and in the production of articles which will find a more ready market. Just as the changes in social conditions and industrial demands have been speeded up by abnormal causes from outside the Province, so the craftsmen's ideas and methods need to be improved by external help to enable them to bridge the gap in the centuries. This does not necessarily mean the exploitation of the craftsman, or the destruction of village industries; quite the contrary.

But there is another line along which much can be done to develop the industries and improve the prospects of the workers, and that is in the matter of organisation. Recently a co-operative loan society has been started at Pagan, and while it is too soon to give any account of results, this co-operative society cannot fail to ameliorate the financial condition of the members, and to put them in a stronger position as regards the holding of stocks and the handling of orders, while they should be able to benefit to some extent by purchasing their materials in bulk at cheaper rates. There is still a demand for lacquer ware in the Province, and there would be a much greater demand were the craftsmen to modify their output to suit present needs. The workers, however, are so anxious to secure sales that they undersell one another to the limit of their ability and thus keep their profits down to the starvation point. Loan societies will not help them here, the co-operation must be carried into production.

I spoke just now of the imports of Japanese lacquer ware. As compared with Pagan ware the Japanese ware is more highly finished on the surface and the shapes are more in accordance with modern demands. I am, of course, not speaking of high-class Japanese lacquer which has national characteristics, just as the high-class Pagan ware has its own characteristics. I am thinking of comparatively cheap wares. There is no reason at all why the Pagan craftsmen should not make all these articles, and put them on the Rangoon and Indian markets at the rates they now fetch and at considerable profit to themselves. There is no reason, that is to say, provided they follow possible lines of progress. They can at present produce this high finish, but only at considerable expenditure in labour. The secret is to change from a bamboo to a wooden framework, and to make one or

two quite simple alterations in the process of lacquering. But here the craft suffers, as many Burmese crafts suffer, from isolation; single crafts occur in village areas and the crafts with which they need to combine are only practised in other village areas. It will be necessary to introduce carpentry on a big scale into Pagan; timber can be had in plenty by transport down the river from the forests.

Now the problem, as it seems to me, is largely educational, using the word in a wide sense; but I believe a great deal might be done by education in the narrower sense. I have already referred to the vernacular education system of the country, which, excellent as it is, does not lead very far, and in a village area with a distinct industry I see no reason why the education should not be made vocational for some of the villagers, as I have suggested for supplementary industries. I would take in this case the special vocation already indigenous to the area and teach it as an optional side of part of the vernacular curriculum, not greatly altering the curriculum for these students, but making it centre round the industry. I would suggest introducing carpentry in addition for the senior students, not from the point of view of its "hand and eye" training value, but as a definite introduction to the craft. If carpentry were introduced into the vernacular schools at Pagan and taught properly by a really qualified man a good many of the pupils would doubtless drift away to other centres where they would find lucrative employment. But the Burman is "a homing bird," and if he can find reasonably good employment in his own village he prefers to remain there, so a sufficient number of young carpenters would stay to carry the lacquer-ware industry forward to the making of all those articles now imported from Japan.

Quite recently, with the help of the Indian Trades Commissioner, I held a small exhibition of Burmese village wares in London. The exhibition was not open to the general public, but was meant for traders in Oriental wares and others who might care to take up the marketing of our Burmese village products in Europe. The result was most interesting, and the views expressed were as contradictory as it is possible to imagine. A particular line of goods would seem to one dealer suitable for import and likely to find a ready sale, while another line in his opinion had no chance on the European market. His successor would absolutely reverse the order and show keen enthusiasm for the wares which his predecessor had condemned. But there is one point which, apart from high-class art wares, will certainly be a weakness with the Burma village industries for some time to come. The home importer wants quantity; he talks of an order for several thousand pounds' worth of certain goods, and when you say you could only supply as many hundred pounds' worth he shrugs his shoulders and goes away. Now, that is a weak point. The quantity production village industries need this export trade; they cannot immediately produce the quantities required by exporters, and the exporters will not give them orders such as they could work up to immediately. It is true that the lacquer industry at Pagan has, as I have said, a value of some lakhs of rupees, but a great part of this will always be absorbed by the Province, and anyhow at present only a very small proportion would be worth exporting to Europe. But it is the export trade which will really help them, and they must try to secure it. And, indeed, the Pagan lacquer industry is the least convincing example I could have taken in regard to this point, because it has a fairly large output concentrated in a small area. This, of course, facilitates trading. With most of the village industries the output of any one individual group is nothing like as large as this. And here it seems to me there is need for action in the way of helping these workers to organise sufficiently to enable them to take up big orders and to secure the confidence of firms in England. Until such organisation is sufficiently developed, industrial bureaux, such as I have described, would be useful as go-betweens to link up the craftsmen and the European importers. Co-operative loan societies are not sufficient. The development of organisation is a change which the craftsmen cannot accomplish alone; they need help because the change is too great for them, too sudden for them to evolve naturally. If this matter could be left to private enterprise, private enterprise would already have accomplished it; all that private enterprise has accomplished so far is to absorb the greater portion of the retail prices by uneconomical collection and distribution, and thus to speed the decay of the industries. Now, it may be said, "That is all very well, but lacquer is only one industry; you may perhaps have made a reasonably attractive picture of the possible development of this industry, but are the others equally likely to succeed?" My reply is that I have too much compassion for my audience to presume on their patience by taking each industry in turn and dealing with it in detail.

The treatment in each case must be different, owing to the particular and peculiar difficulties of each industry. I could show you that conservatism all but killed the Burmese umbrella industry, which was rapidly dying chiefly owing to the fact that the Burman learned to prefer the crooked handle of the European umbrella in place of the straight handle of the Burman article, and it was not till the Burmese makers learned at last to use crooked handles that the industry began again to come into its own. I could give you other instances of uneconomical distribution, such as that in the black pottery industry, where articles made at Letthit are sold in Mandalay, twenty miles away, at prices four or five times that which the craftsman receives. I prefer to call this uneconomical distribution, and leave the question open as to whether the middleman is rapacious or no; sometimes it is rapacity, but in some cases these rates are really due to waste of labour. I could give you further instances of how small experiments carried out with the help of the craftsmen have led to improved methods and sales. Or I might instance how recent experimental work on the use of paddy husk as a fuel in connection with the native type of kiln has gone far to solve the fuel problem for Lower Burma potters whose industry was being killed by the cost of timber fuel. But I should only be repeating the arguments and wasting your time. The points which I wish to make are that these industries suffer—

(1) From the conservatism of the craftsman.

(2) From uneconomical distribution.

(3) From the rapid change of popular demands which have left the craftsmen to-day far behind in the race for trade.

To me it seems these difficulties can be overcome by—

(1) The extension of technical education of a simple type in the vernacular schools, fostering the crafts indigenous to the areas treated.

(2) By organising the craftsmen so that they can themselves deal with wholesale firms in the large centres, and by selling in bulk reduce the costs of distribution and consequently improve their own profits.

(3) By patient experiment side by side with the craftsmen, studying with them the possibilities of manufacturing such things as are in present demand, and meeting the difficulties if possible by simple adjustments of processes. Indeed, if they cannot be met by simple adjustments it is better not to try them.

These quantity production village industries are of great importance; they employ a large number of people, they might be a considerable item in the development of the national prosperity, and they are the natural source of supply for workers in those necessary industries which I have grouped under my heading of trades.

And this is my last group. Possibly I ought to apologise for introducing it at all, but it has a very distinct connection with the subject. By the trades I mean those crafts in which there is nothing of a national characteristic, but which are in their present state absolutely modern, and generally a matter of collective effort. On these trades all modern manufacturing processes and all modern industries depend. I refer to such occupations as the various building trades, and the crafts practised in engineering shops. In such the Burman has at present but a small part, yet building is a village almost as much as a town industry, and the Burman did all his building in the past both in timber and brick. You can see Indian labour employed nowadays on pagodas, a state of things which does not add to the correctness of the details of Burmese architecture. And in the engineering shops only a very small amount of the skilled labour is Burmese. The Burman is found in the moulding shop and at natty work of that sort, and to some extent in the pattern shop, but in all the other shops he is very much in the minority.

The reason for this is that the Burman has not had a fair chance to adjust himself to the rapidly changing conditions. When the railway and other shops were started those in authority needed skilled labour immediately, and they imported it from India. And those in charge of the shops, the foremen and others, often either Eurasians from India or Englishmen trained in India, understood Indian labour and knew how to deal with it, but had no knowledge or understanding of the Burmese. In the same way Chinese carpenters from Singapore flooded the country, and of course the Chinaman has a very well justified character for honesty and hard work which finds him a ready welcome. In the building trades, for modern brick work, Indian labourers already trained are introduced, and so on through all the trades.

I do not see how this could have been helped, anyhow at first. Work had to be done and done efficiently. But the natural sources for craftsmen in new trades are the existing craft industries of a country, and this in itself is a strong argument for the fostering of the existing village industries and helping them to a more

rapid development. And it is here that these trades link up with my main subject.

The work of supplying craftsmen for these trades is wholly educational. This the Indian Industrial Commission to some extent recognise in their report. There is an idea at home that craftsmen must be trained entirely in the workshops by a long apprenticeship, and any attempts at intensive training are resisted. It is indisputable that you cannot finish a craftsman in a school, he must have some part of his training in the shop; but from what I have seen lately of craft training in England I believe that the old seven years' apprenticeship is wasteful, that some years might be saved if the initial stages were done by intensive training in schools. But, be that as it may, in Burma anything except direct educational effort is well-nigh out of the question. The large proportion of Indian labour, and the very mixed type of that labour, makes training of young Burmans in the shops both difficult and unsatisfactory; the wastage is very high. It would be a real saving to the community to give the youths some three years' training in schools, and then let them go to the shops as improvers—often in this case they would on entry into the shop be considerably better than the average so-called skilled Indian labourer employed. And in the building trades there is no apprenticeship possible, while in carpentry the Chinese form a closed guild. In a very small way we have put this to the test at the Government Engineering School in Insein, with satisfactory results. It is only a question of raising the experiments to a real commercial scale. Our present scale is two pupils per year. The young Burman takes readily to handwork, that is to say if you recruit from the right source. If you take the son of a ploughman who has been for generations descended from ploughmen, you cannot expect him to become much of a craftsman. If you take a youth whose surroundings and training have led him to regard life on an office stool as the *summum bonum* of his working existence, then, naturally, you may have to exert considerable effort to induce him to see the greater dignity of intelligent craftsmanship. But if you recruit from the right source you have good material worth training, and in spite of his faults, his human weaknesses, and his lapses from rigid industrial self-discipline, I will say this for the young Burman—he is a very loveable sinner and readily responds to sympathetic instruction.

So much, then, for the Burman craftsman and his industries. For one having a leaning towards education, the educational needs perhaps appear strongest, but in justification of that attitude I would again emphasise the very great change which has come over the country owing to its contact with the West—a change so great and rapid as to leave the natural and uninstructed craftsmen hopelessly behind.

In making suggestions I have, I am aware, put forward what some regard as heretical doctrines. I have advocated vocational education in the schools. Well, I hold that all right education has a vocational function. It is not its only function, but there is a tendency among some theorists to forget that this is a function of education. If the schools fail to leave the youth fitted for some part in the world's work, he must perforce acquire that knowledge after leaving school, and generally he acquires it in a haphazard and therefore uneconomical fashion. It is a question as to when the vocational side of education should have its first emphasis, but that it should be attached to the school training and not left to unguided absorption I have no doubt whatever.

In a very able paper read before this Society a fortnight ago, the author, Mr. Hartog, quotes the oft-repeated remark that Indian education is like a top-heavy pyramid, and he deprecates the suggested remedy that the apex should be lopped off, but advocates rather that we should widen the base. I do not think anyone who cares at all for the educational work now being done in India could fail to agree with him; we cannot, and would not, reduce the height, but it is for the broadening of the base that I stand here. And of course a base has two dimensions. If you widen it as regards the numbers of pupils, you must also widen it as regards the subjects, not by a greater number of subjects for each pupil, but by a wider choice of subject groups. To one whose interests lie, as do mine, in the lower strata of education, this plea for broadening the base has a special appeal. You may train your scientific, your technical, experts of high university degree, but unless you prepare the substrata, the craftsman and all that lie between him and the engineering expert, or the scientific specialist, to what purpose is your higher training? And in this the development of village industries can play an important part. For that work education and organisation are necessary. Owing to the rapid changes in the condition of Burma, the work of organisation cannot be left to simple evolution; the evolution must be quickened by some special

stimulus, by direct effort. It may, it does at times, need all the three graces of faith, imagination, and love to visualise the development of these industries, to view their future with optimism. But their present vitality gives ground for faith; the small measures of success already obtained encourage imagination, and no one who has had anything to do with these industries and the men employed on them can fail to feel some real regard for them.

I set out to show that some handicrafts are desirable, that in some cases the causes which have weakened the industries can be excised and removed by suitable treatment, that certain industries have already been improved by aid which cannot be called mere benevolent bolstering. I have endeavoured to give reasons for my ideas and some indication of the remedies which I regard as necessary. I may have been speaking to those who did not require proof of these things, I have certainly put forward views which are liable to criticism, and the real value of this paper—if it has any at all—will be in the discussion which I hope it will raise.

DISCUSSION.

THE CHAIRMAN (Sir Harvey Adamson) said he was sure all would agree with him that Mr. Morris had given them a most interesting and instructive paper. If he might venture on a word of criticism he would suggest that the title—" Burmese Village Industries "—was somewhat of a misnomer. Take, for example, the silk industry of Amarapura and the lacquer industry of Pagan. These places were small towns, the headquarters of sub-divisions, and were not villages as the term was understood in Burma. Similarly, the centres of activity of gold, silver, bronze, and kindred arts were towns or very large villages. He preferred to call such industries the minor industries of Burma. The industries conducted in the ordinary village, which he might call all-village industries, were in a backward state. In most villages would be found weavers of cotton, all women, a carpenter, blacksmith, some makers of mats, baskets, agricultural implements and cheroots. The weaving was excellent, though the loom was primitive. Other village products—such as oil mills, sugar mills, dahs or knives, boxes, and implements, were very crude. Every man was his own house-builder, the houses being built of bamboo, with a plank flooring and thatched roof. The Burman was a poor carpenter. Most of the industries carried on in the villages were in the same condition as they were hundreds of years ago. He hoped that in any steps taken for the improvement of the industries of Burma, these all-village industries would not be neglected. Speaking generally, it was to this source that they must look for the supplementary industries which were needed so much, especially in Lower Burma, where every villager was a cultivator of rice, which occupied his time for only a portion of the year. Turning from all-village industries to industries in lacquer, silk, gold, silver, and bronze, it was amazing to see such beautiful objects produced by a people who were so backward in their ordinary village industries. Skilled instruction—for which great credit was due to the author of the paper—combined with latent native talent, had enabled the Burman to turn out the most exquisite objects of art, and he advised the audience to pay a visit to the Indian Galleries of the Imperial Institute to inspect the examples which had been brought over to this country by Mr. Morris. Mr. Morris had mentioned the difficulty in finding a market in London for the village wares owing to the impossibility of producing the article required in sufficiently large quantities for the trade buyers. Still, he thought purchasers ought readily to be found for the art productions. Mr. Morris had not attempted to enumerate the industries of Burma. He (the Chairman) would add toy-making as a quantity-production industry. Burmese toys were very quaint and very fascinating to children, and they had the advantage of being cheap. On several occasions he himself had sent over consignments for disposal here for charitable purposes, and they had all been snapped up, even at the high prices fixed for a charity bazaar. He thought it very possible that Burmese toys could be produced in sufficiently large quantities for exportation to this country. The one example at present showing what instruction combined with co-operation could do was afforded by the silk industry of Amarapura, particulars of which were given in the paper. He did not quite share Mr. Morris's views as to the possibilities of sericulture. He thought the workers would still have to rely upon imported silk. Sericulture involved the sacrifice of life, which was contrary to the Buddhist religion, and in Lower Burma—where at one time there were many quite flourishing concerns—those engaged in the work had been ostracised and not allowed to intermarry with other Burmans, so that their lives had been made most unpleasant. This isolation, combined with increased imports of silk yarn, had destroyed the trade, and he doubted very much if it could be revived to any appreciable extent. The silk-weaving industry was up to date, the one example of improvement, but *ex uno disce omnes*. The Burman was very conservative, but he was always ready to follow a good lead, and showed not a little initiative in adopting it. Many instances of this characteristic could be mentioned. Co-operation was one. It was only a few years since the co-operative movement was introduced into Burma. Now there were a good many well-managed co-operative banks and credit societies. Another instance was the army. During the Great War, for the first time Burmese battalions were raised, and he had been informed that in the use of machine-guns, signalling, pioneer, and sapper work they showed general intelligence

far above the ordinary infantry units of India. As a third instance, Mr. Morris had once told him that he had Burmans in his engineering school, who, after a short course of instruction, had beaten the Chinese in the craft in which they excelled—carpentry. In this characteristic of the Burman, supplemented by instruction on the lines suggested by Mr. Morris in his paper, lay the soundest hopes for improving the minor industries of Burma.

MR. C. W. DUNN, I.C.S., late Registrar of Co-operative Societies in Burma, said the author of the paper had been extremely modest with regard to his own contributions towards the improvements in Burmese minor industries. He believed the method of showing the red figures on the black pottery was really invented by Mr. Morris, and that the utilisation of paddy husk as a fuel in the native kilns was also due to his researches. For the past eight years he (the speaker) had been associated with co-operation in Burma. They had no Department of Industries, except so far as Mr. Morris himself supplied this want, and the movement therefore had perhaps not received as much support as it deserved. Work, which in some provinces was performed by Directors of Industries, had to be done by officials serving with the Co-operative Department, but was limited in amount owing to their other duties. With regard to what Sir Harvey Adamson called the "minor industries," silk weaving required a division of labour, centred under one control; in fact it seemed to him to be a factory and not a cottage or home industry. The Government no doubt could help the industries by teaching improved methods. But he thought the Burmese themselves were capable of developing production by organising factories under joint-stock companies or co-operative societies. Indeed, they had started a Co-operative Weaving Society or Company at Amarapura within the last year. The workmen had combined with a certain number of master weavers to form this company, in which the workers did the weaving and the masters undertook the sales of the products and the supply of raw materials. It did not seem to him that this could be called a village industry. He took it that Mr. Morris meant home industries, upon which the people are employed in their own houses or cottages, separately. The cotton industry, as at present carried on in Burma, was to a great extent a home industry. The weaving was done by people who either grew their own cotton or bought yarn for the purpose. The work was done by the villagers' wives and daughters, who sold the cloth to itinerant middlemen. The rough cotton fabrics produced in Northern Burma were readily disposed of in competition with imported goods, because of their superior strength and good wearing qualities. The Government were now proposing to inaugurate temporary local itinerant art schools, with the assistance of the co-operative organisations. The local co-operative society would apply to the department for an itinerant teacher, and raise sufficient funds to erect a temporary school. The Amarapura Weaving School would send a trained teacher to the locality for from three to six months, until the supply of persons requiring instruction was exhausted. The teacher would then move on to another centre. This plan would avoid any excessive centralisation. Generally speaking, Mr. Morris proposed that the Government should intervene and control the sale of the products of these minor or village industries, and presumably undertake the risk of purchasing stocks for which perhaps there might be no market. It seemed to him that that would be a difficult problem for the Government or for the co-operative societies, and he thought the former were wise in acting cautiously. It was really more a matter for the Burmese middlemen, who were acquainted with the wants of their customers. Within the last two or three years there had been considerable development in urban credit societies, which were intended as banks for the middle classes and people of moderate means. These societies were able to finance small traders and manufacturers up to, say, Rs. 10,000. It was extremely difficult for the limited number of Government officials available to discover and develop profitable lines of industry in different parts of the country.

MAJOR A. A. LONGDEN, D.S.O., asked Mr. Morris if he could say how many household arts were thoroughly taught in schools in the Philippines. At the present time the British market was overrun with the work of partially-trained disabled soldiers and sailors which was sold at exhibitions and bazaars, etc., and he was afraid this tended to have a detrimental effect on the disposal of the legitimate work of *bonâ fide* artistic craftsmen.

MR. W. H. EVANS said one difficulty that occurred to him in connection with the paper was the superimposing of Western culture upon an Eastern people in the development of their art and industries. But the paper had shown how improvements had been effected by allowing the conservative native craftsman, with a little pressure, to make progress along his own lines of work. He would like to ask Mr. Morris if he had any information to give respecting Burmese work in semi-precious stones. Recently there had been considerable inquiry in this country regarding such work, owing to the elimination for the time being of the German craftsmen in semi-precious stones, more particularly amber. New sources of supply were being sought for, with, he was afraid, very little result. Germany seemed to be specially endowed by nature with large deposits of amber suitable for the production of high-class ornaments, and he thought possibly alternative supplies might be procurable from Burma. With regard to the difficulty of disposing of the art productions of the Burmese villages, he thought perhaps this to some extent could be overcome by co-operating with kindred Home Arts and Industries Associations in this country, who might be willing to include the Burmese art wares in their sales exhibitions.

Mr. Davidson Keith asked why all the speakers seemed to depend upon the home industries of Burma. He thought such industries were best carried on in factories. Only by working in combination with others could the Burmese be induced to adopt new appliances and improved methods. He also spoke of the advisability of beginning with young people and giving them a good education.

Lord Carmichael, G.C.S.I., G.C.I.E., K.C.M.G., in proposing a vote of thanks to Mr. Morris for his paper, suggested that in seeking an outlet in this country for Burmese wares, it was not necessary to restrict themselves to buyers who would purchase only in thousands. The tendency nowadays was to encourage people to look to the Government for every form of help. Whilst Government aid was useful up to a certain point, and especially in providing banking facilities, private initiative and enterprise were most important in schemes for development. In many parts of India the native industries were undoubtedly being displaced by European manufactures, generally of German origin, and, since he left the country, he believed by Japanese. Personally, he thought many of the German goods very ugly. But the German merchants adapted their productions to the pockets of the poorer people, and gave longer credit. The Germans also attended more to details. The little models of gods which they offered for sale were more accurately made, and generally they paid greater attention to iconology than our own manufacturers did. He did not profess to be a financial expert, and he thought that, as a rule, Government officials were very poor financiers and did not know very much about trade matters.

Mr. Davidson Keith remarked that the Australian Commonwealth and State Governments were doing well in fostering manufactures.

Lord Carmichael said he hoped that was so; but unless things had altered since he left Australia, he thought the Government of Australia were more anxious to develop manufactures on a larger scale than was possible in Burma. Such manufactures as the Australians were encouraging required to be made in large factories, and could not be looked upon as home or village industries.

Mr. D. T. Chadwick, I.C.S., seconded the resolution. Mr. Morris, he said, was an enthusiast in his work, and his paper was very stimulating. It was also timely, coming as it did at a moment when considerable attention was being paid to the desirability of granting facilities through co-operative societies and joint-stock companies for the development of overseas trade.

Colonel C. E. Yate, C.S.I., C.M.G., M.P., in supporting the resolution, said he had never been in Burma, and consequently he could not speak with any knowledge of that country, but there was one thing in which he could sympathise most thoroughly with the author of the paper, and that was in the remarks he had made on the subject of education. He presumed that education in Burma was an offshoot from education in India, and he looked upon the Indian system of education as the worst in the world, and now that Burma had escaped from being drawn into the vortex of the Government of India Bill, he hoped the authorities in Burma would evolve a system of education and handicraft training suited to the needs of the country, and capable of enabling a boy to earn his living in the trade he was best fitted for.

The resolution was carried unanimously.

Mr. Morris, in reply, said that a kindly regard for an amateur effort had reduced adverse criticism. He must confess that he had deceived them; Sir Harvey Adamson said that he had not dealt with the village industries. At the same time the industries with which he had dealt were those with which he meant to deal. He apologised to the gentleman who exclaimed that a ploughman was a craftsman—of course he was; but he had more or less limited his use of the word craftsman in introducing his subject, and under this limitation the ploughman was not included. He only instanced him as an illustration of the advisability of taking into account heredity in selecting recruits for the handicrafts. He did not altogether agree with Mr. Dunn in his ideas on the silk industry. It was a village industry in the past, a cottage industry, and he could not see why it should not continue to be so under the new conditions. To him the possibility of preserving cotton weaving as a cottage industry seemed much more difficult. Sir Harvey said quite rightly that silk-growing was not likely to succeed among Buddhists, but the areas more likely to be suitable, the Shan States, contained large numbers of Christians and Animists, who would have no religious objections to sericulture. Mr. Dunn spoke of the co-operative societies accumulating stocks which would not find a sale. The system of bureaux which he (Mr. Morris) advocated would not be provided by co-operative societies; and while Government might occasionally lose a little on experimental work, they need not, if properly run, incur great risk. The system had anyhow succeeded in the Philippines, and need not fail in Burma. Major Longden asked what were the housekeeping and household arts taught. He was afraid he could give no details; the quotation was from the book mentioned. As regarded the desirability of completing instruction before allowing profitable manufacture, he was giving his own view, and that was the method they had adopted in their craft apprenticeship classes in Insein. Mr. Evans asked about amber. They had supplies of amber in the north of Upper Burma. They had never been developed, and apparently were not large. A

small quantity only came down to Mandalay and was worked into small articles. He described the processes of manufacture of some of the Burmese wares on view at the meeting. In conclusion he said it had been a pleasure to him to speak about the industries of Burma. He believed that a great deal could be done to help them, and that it was well worth while doing it.

LABOUR SCARCITY IN BRITISH GUIANA.

In the discussion on Sir Edward Davson's paper, "Problems of the West Indies" (*Journal*, December 26th, 1919), the Hon. C. Clementi, Colonial Secretary, British Guiana, referred to the injury which that Colony suffers by the smallness of its population. They had, he said, attempted to import labour from the West Indies, but, except in the case of Barbados, none could be spared, and even if the whole population of Barbados was transported to Demerara there would still only be five persons to the square mile. They had to look to countries where the population numbered hundreds of millions, and naturally turned their thoughts to India. Negotiations, he added, had been opened with the Government of India for that purpose. A deputation, representing British Guiana and the West India Committee, was in India when a recent mail left, and it was received by Sir George Barnes (Member of Council in charge of the Department of Industry and Commerce) at Delhi, on December 5th. The principal spokesman of the deputation, the Hon. J. J. Nunan, K.C., LL.D., explained that the scheme contained no trace of the old indentured system, which public opinion in India compelled the authorities there to abolish, and that no contract of any kind would be required. It was proposed to offer free passages and guarantee employment at locally current rates, now about two rupees a day. Free repatriation would be afforded at the option of the individual or family after a short period of years, or at any stage when desired by the supervising officers of the Indian Government. Those immigrants who engaged in agricultural work, either for an employer or on their own behalf, for three years would receive grants of five acres on nominal terms. Additional land could be bought or leased. Regular steamer communication with two classes of passenger accommodation would be provided by the aid of colonial subsidies between Indian ports and British Guiana, and India would incur no expense. As the population was now about 45 per cent. Indian (14,500), and as the constitution involved the political equality of all races, they were really offering India a colony of its own on the north-eastern coast of South America, with fertile soil and a healthier climate than that of India or any large tropical colony. The immediate scheme was limited to 5,000 adults of both sexes per annum for the next three years.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

JANUARY 28.—SIR CECIL HERTSLET, late H.B.M. Consul-General for Belgium, "The Ruin and Restoration of Belgium." EMILE CAMMAERTS will preside.

FEBRUARY 4.—ALFRED E. HAYES, General Secretary, English Language Union, "The English Language and International Trade."

FEBRUARY 11.—LIEUT.-COMMANDER NORMAN WILKINSON, R.N.V.R., O.B.E., R.O.I., R.I., "Naval Camouflage."

FEBRUARY 18.—SIDNEY PRESTON, C.I.E., "English Canals and Inland Waterways." NEVILLE CHAMBERLAIN, M.P., will preside.

FEBRUARY 25.—JAMES CURRIE, C.M.G. Ministry of Labour (Training Department), late Principal, Gordon Memorial College, Khartoum, "Industrial Training."

MARCH 3.—WILLIAM JAMES GARNETT, First Secretary, H.B.M. Diplomatic Service, "Mongolia from the Commercial Point of View."

MARCH 10.—H. M. THORNTON, "Gas in relation to Industry and Housing."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

FEBRUARY 3.—SIR FRANCIS WATTS, K.C.M.G., D.Sc., Imperial Commissioner of Agriculture for the West Indies, "Tropical Departments of Agriculture, with special reference to the West Indies." LIEUT.-COLONEL SIR DAVID PRAIN, C.M.G., C.I.E., LL.D., F.R.S., Director of the Royal Botanic Gardens, Kew, will preside.

MARCH 2.—G. F. SCOTT ELLIOT, M.A., B.Sc., F.R.G.S., "Trade Routes for the Empire in Africa." COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., will preside.

Dates to be hereafter announced:—

AIR-COMMODORE EDWARD MAITLAND, C.M.G., D.S.O., "The Commercial Future of Airships."

CHARLES H. SHERRILL, "Stained Glass."

LADY INGLEFIELD, President, Buckinghamshire Lace Association (North Bucks and Bedfordshire), "The Hand-made Lace Industry."

GRAILY HEWITT, "Rolls of Honour."

CHARLES CROWTHER, "The Arts and Crafts of Japan" (with examples from the author's private collection).

WILLIAM CRAMP, D.Sc., M.I.E.E., "Pneumatic Convoying Plants, with special reference to the Transport of Grain."

L. GASTER, "Industrial Lighting in its relation to Efficiency."

BRIGADIER-GENERAL LORD MONTAGU OF BEAULIEU, C.S.I., "Roads and Transport in India."

SIR GEORGE CUNNINGHAM BUCHANAN, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

SIR VALENTINE CHIROL, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

PROFESSOR WILLIAM A. BONE, D.Sc., Ph.D., F.R.S., "Lignite."

INDIAN SECTION.

Thursday afternoons, at 4.30 p.m:—
February 19, March 18, April 15, May 20.

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—
February 3, March 2, May 4.

CANTOR LECTURES.

Monday evenings, at 8 p.m.:—

CAPTAIN H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S., Fellow of Downing College, Cambridge, and formerly of the Royal Air Force, "Aircraft Photography in War and Peace." Three Lectures.

Syllabus.

LECTURE II.—JANUARY 26.—The employment of aerial photographs in war—The interpretation of photographs — Types of intelligence furnished—Artillery work — Effects of air photography on strategy.

LECTURE III.—FEBRUARY 2.—The use of aerial photography in exploration and survey in times of peace—Comparison of a photograph with a map—How maps may be compiled or improved—Application to exploration—Things concealed and revealed—Surveys for special purposes—Limitations and future of the method.

CHARLES FREDERICK CROSS, B.Sc., F.R.S., F.C.S., "Recent Research in Cellulose Industry." Three Lectures.
February 16, 23, March 1.

WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.
April 12, 19, 26.

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.
May 3, 10, 17.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JANUARY 26...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Captain H. H. Thomas, "Aircraft Photography in War and Peace." (Lecture II.)

TUESDAY, JANUARY 27...Illuminating Engineering Society at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Mr. W. C. Martin, "Colour Matching by Natural and Artificial Light."

Royal Dublin Society, Leinster House, Dublin, 4.15 p.m. 1. Professor J. Wilson, "The Application of the Food-Unit Method to the Fattening of Cattle." 2. Professor H. H. Dixon and Mr. H. H. Poole, "Photosynthesis and the Electronic Theory."

Royal Institution, Albemarle-street, W., 3 p.m. Professor G. Elliot Smith, "The Evolution of Man and the Early History of Civilisation." (Lecture I.

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Discussion on following papers:— 1. Mr. J. Mitchell, "Whitby Harbour Improvement." 2. Mr. R. F. Hindmarsh, "The Design of Harbours and Breakwaters with a View to the Reduction of Wave-Action within Them." 3. Mr. J. W. Sandeman, "Wave-Action in Harbour Areas: with Special Reference to Works for Reducing it at Blyth and Whitby Harbours." 4. Mr. W. Simpson, "The Improvement of the Entrance to Sunderland Harbour, with Reference to the Reduction of Wave-Action."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Major W. Bladon, "Life on the Gold Coast."

Colonial Institute, Central Hall, Westminster, S.W., 8 p.m.

Marine Engineers, Institute of, The Minories, Tower-hill, E., 6.30 p.m. Paper by the President.

Industrial League and Council, Carpenters' Hall, Throgmorton-avenue, E.C., 5.15 p.m. Professor M. Garnett, "Industrial Problems."

WEDNESDAY, JANUARY 28...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Sir Cecil Hertslet, "The Ruin and Restoration of Belgium."

THURSDAY, JANUARY 29...Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Medicine, Royal Society of, 1, Wimpole Street, W., 5.30 p.m. Dr. N. Wood, "The Merits and Defects of the British Health Resorts."

Royal Institution, Albemarle-street, W., 3 p.m. Dr. R. R. Terry, "Renaissance Music in Italy and England." (Lecture III.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Lecture by Dr. C. Atkin Swan.

Dyers and Colourists, Society of (Bradford Junior Branch), Huddersfield. Professor E. Midgley, "Some Defects Developed during Dyeing and Finishing."

Mechanical Engineers, Institution of, at the South Wales Institute of Engineers, Park-place, Cardiff, 6 p.m. Mr. E. M. Bergstrom, "Recent Advances in the Utilisation of Water Power."

FRIDAY, JANUARY 30...Royal Institution, Albemarle-street, W., 9 p.m. Mr. S. G. Brown, "The Gyrostatic Compass."

Engineers and Shipbuilders, North-East Coast Institution of, Bolbec Hall, Westgate-road, Newcastle-on-Tyne, 6.15 p.m. Mr. F. J. Cook, "Castings for Internal-combustion Engines."

University of London, University College, Gower-street, W.C., 5 p.m. Dr. T. Borenius, "Mediæval Art." (Lecture III.)

SATURDAY, JANUARY 31...Royal Institution, Albemarle-street, W., 3 p.m. Sir Frank W. Dyson, "The Astronomical Evidence Bearing on Einstein's Theory of Gravitation." (Lecture I.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 2nd, at 8 p.m. (Cantor Lecture.) CAPTAIN H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S., Fellow of Downing College, Cambridge, and formerly of the Royal Air Force, "Aircraft Photography in War and Peace." (Lecture III.)

TUESDAY, FEBRUARY 3rd, at 4.30 p.m. (Colonial Section.) SIR FRANCIS WATTS, K.C.M.G., D.Sc., Imperial Commissioner of Agriculture for the West Indies, "Tropical Departments of Agriculture, with special reference to the West Indies." LIEUT.-COLONEL SIR DAVID PRAIN, C.M.G., C.I.E., LL.D., F.R.S., Director of the Royal Botanic Gardens, Kew, will preside.

WEDNESDAY, FEBRUARY 4th, at 4.30 p.m. (Ordinary Meeting.) ALFRED E. HAYES, General Secretary, English Language Union, "The English Language and International Trade." SIR EDWARD W. BRABROOK, C.B., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, January 26th, LIEUT.-COLONEL ALLAN J. C. CUNNINGHAM in the chair, CAPTAIN H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S., Fellow of Downing College, Cambridge, delivered the second lecture of his course on "Aircraft Photography in War and Peace."

The lectures will be published in the *Journal* during the summer recess.

SEVENTH ORDINARY MEETING.

WEDNESDAY, JANUARY 28th, 1920; MONSIEUR EMILE CAMMAERTS in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Cameron, Alexander, Sunderland.
Campbell, Archibald Jack, Dalmuir, Scotland.
Subedar, Ardeshir Rustumji, Bombay, India.

The following candidates were balloted for and duly elected Fellows of the Society:—

Barnes, Jabez, J.P., Harrow.
Haigh, Bernard Marker, M.B.E., D.Sc., London.
Hammer, K. V., Christiania, Norway.
Horsnell, Daniel Thomas, M.I.Mech.E., M.I.Mar.E., London.
Howard, Henry Eliot, J.P., Stourport.
Jack, Robert Wilson, Girvan, N.B.
Kemp, Mrs. Mabel Amy, London.
Longstaff, Captain George William, R.A.F., London.
Mitchell, Harold F., London.
Mukharji, J., Srinagar, India.
Ogden, Alfred, Manchester.
Oldfield, Percy Jack, London.
Parsons, Robert Hodson, Assoc.M.Inst.C.E., Chingford.
Scott, James P., Birmingham.
Stuart, George Archibald Douglas, Bournemouth.
Tidswell, Mrs. Mary Florence, London.

PROCEEDINGS OF THE SOCIETY.

SIXTH ORDINARY MEETING.

WEDNESDAY, JANUARY 21st, 1920; The Right HON. EARL FERRERS in the chair.

The paper read was—

ANCIENT COTTAGES AND MODERN REQUIREMENTS.

By ALFRED H. POWELL.

Of the many calls upon us for increased production, perhaps the most serious one is for houses. Much of this work will be the building of new houses and much will be the making good of our old ones. It is in the hope that I may be able to say something to help this making good—to prevent, it may be, unintentional making bad, that I have ventured to accept the Council's invitation to read a paper here. I will say a word to begin with in explanation of my title. I quite realise the necessity of adapting and refitting old cottages to modern use, but I feel it must be one of our

first aims to look to the buildings themselves as part of an even larger question than this present one of accommodation. For a great many of them are of such a kind that their demolition or mishandling would be a serious national loss. We shall therefore, I think, agree that architectural character, history and quality of workmanship should be to a great extent our guide in adapting ancient cottages to modern requirements. The more we look into it the more ready I think we shall be to feel that often a considerable sacrifice of material convenience may be not only advisable, but an obvious piece of common sense, and I ask you not to think me intolerant of many modern inventions and comforts if I emphasise rather the qualities and characteristics belonging to ancient buildings.

I am going to try, then, to tell you what I feel about their claims upon us as an ancient inheritance—to show in some degree how they were built; and finally, if there is time, to say something of their past and present occupants, for I think we can hardly come to appreciate the buildings without some consideration of their time-honoured use.

One thing appears very clearly at the outset, that, whereas the new houses will be just new houses, the old ones have for many generations been *homes*. However well, however thoughtfully we architects go to our work of housing, however nicely planned and outsided the new houses may be, they cannot all at once become homes. It takes long association and use to make a house into a home, and age, which is the reward of wise building, is the perfection of architecture.

There is, perhaps, no country in the world that can show in so small a space as England so great a proportion of ancient cottages, well built and beautifully gardened, and still in wonderful working order. They are our peculiar inheritance, and we are not alone in looking upon them as the chief beauty of these islands. Not only our own kith and kin, but strangers from overseas have come to look on them as in great degree the very gist of English country; and we have a duty, it seems to me, laid on us as English to safeguard these buildings, remembering not only ourselves, but those also who at times come from the colonies to seek out, among English hills and meadows, their own old family homes. We who live with them always and see them daily may easily come to take them as a matter of course. Like the stars in the sky, for us they have "always been there"—a part of the landscape—but so much an integral part of England that without them it would be no more the England we know and would cherish. Often during these years of the war I have thought of soldiers and sailors scattered over the world in all kinds of difficulty and danger, and felt how strongly must the thought of these ancient homes have upheld the courage and steadied the faith of thousands by no other means than by just being there in their old places. Certainly, too, those of us who stayed in England, consciously or unconsciously, have owed much to these embodiments of an older life during this time of strange confusion and unsightliness.

Another point we may bear in mind in considering the possible fate of old cottages is that our modern architecture, in spite of all the pains we architects take, is not a popular art with a real message to the people, and the host of new buildings in all our renewed towns and cities practically passes without notice or comment: they are buildings innocent of power to move our hearts—they have little food for the spirit. But with ancient buildings it is not so, and I do not think this is entirely due to their being ancient. Few have not felt the glow of pleasure that any old English village can commonly evoke, while the more celebrated greater works, the mediæval abbeys, the castle, and the churches, make constant appeal to our intelligence and affection.

The deeper reason for this is no doubt unrecognised in a general way, but whereas new work of our own time is bound to be the result of individual effort in a sophisticated age, ancient and mediæval building was democratic in the sense that it was a folk-speech. The common energy of men ran to fine building and the arts, and these became under their hands a language very widely understood by the whole people. And though I have no wish to touch politics, I cannot refrain from asking if it may not be this that is at the root of our present labour distress? From our work there has departed something that we recognise as present in the work of the old builders. We see that their work was able to give them a life within their life, a poetic edge upon all effort. In a word, work appealed to them because it tapped the springs of invention and conscious enjoyment, so that through all their continual struggle for social recognition they kept on making things that still fill us with a pleased wonder. In their buildings, as Professor Lethaby tells us, there was magic even to their makers. I am con-

vinced that by workmanlike consideration of old work, by close looking at the actual substance and form of it—not as critics, still less as imitators, but as interested to the point of doing it, in all work well done—we might learn a new ideal of work and see it as the rational and sufficient outlet for all human activity. I will risk your smiles by telling you that I do not remember a greater pleasure than once sitting in the full sunlight of a summer afternoon astride the ridge of a roof I had in good part built with my own hands, and wishing more of us could have a similar point of view and feel what I felt just then about golf and cricket. I want to keep my paper within its proper limits, but I find it very difficult to refuse the by-products of it or to look upon building as a professional housing expert would, and as perhaps I ought to try to. I want something more than the visible attributes of ancient cottages, though I find that sufficiently unnoticed. I feel that they bear a message, that there is indeed a gospel of ancient buildings that we cannot rightly decipher from the visible structure alone, but must see through that something of the life that created it. In these buildings, so unlike our own, there is closely wrapped up—it cannot but be so—vital truth about life on these islands, and every time we look at them we become insensibly touched by their deep significance for us, and in a thousand ways held together as a nation by their familiar presence.

So, in a way, the tables are turned upon us, and it becomes more "our" requirements that are the introduction to their proper treatment. And though for myself I do not lay claim to any special knowledge of the hidden lore of building, I do think I see that by the study of it and its long history a new insight into work may be possible, an insight likely to reward us, not only through added knowledge, but through the light it will throw upon modern work problems.

All the arts are sprung of use, and are thereby the most direct guides to the long story of the use of houses. We know how slowly customs die and how primitive habits and beliefs endure, and there are buildings at our doors that if properly seen and examined would throw light on these things. The worship of fire is not wholly dead, the significance of the square and the circle, the feeling for position, for true orientation, the imaging of the heavens, and the earth and sea, have all their part in us, and have all found expression in building. Who shall say what may not be the genealogy of our foundation-stones, of thatchers' knops, of vanes, of even square houses? These things hide about us still, and search and discovery are broadening the interest of life. There was a house in Sussex, I remember, to be surveyed for alteration. At first sight it was the ordinary Sussex type. But its roof was large and wide and its walls were of oak and wattle. Examination of the roof brought it at once within the range of origins. The timbers were thickly coated with soot. Gradually its history was sifted out from the modern tenements that encumbered its ancient plan. A central hearth, a large hall with an open roof, screens and offices, all came into their places once the roof had given the clue.

And but yesterday I was in a cottage in Suffolk, built, I suppose, about 1350, where a further step in the story of the hearth was illustrated. The whole end of the house was given up to the fire and its smoke, making a chimney some 15 ft. by 6 ft. of timber and plaster, the hood shrouding the fire and rising in great framed panels of oak and wattled clay through the finely carpentered roof to the ridge, some 30 ft. from the ground.

A book lately published on old methods in building, by Mr. Innocent, is full of interesting details of his research into these things. The book is written with the idea of being helpful now, quite as much as for its explanation of unsuspected origins and primitive building. It cannot be doubted that there are many cottages and other humble buildings still standing whose antiquity is far greater than is commonly supposed, and I would like to see a serious attempt made to examine and schedule all the earlier *little* buildings of England with a view to their proper treatment and preservation. For our present purpose, however, I would call any serious building put up before 1700 an ancient building. As to defining a cottage I find little help in the dictionaries, but if I were asked for a definition I think I would call it a building whose main purpose was to be convenient for workers and work—so small as to be in constant touch with the out-of-door world and the elements—by no means a place to be idle or ill in.

And with all the disadvantages we may conceive of in such dwellings, there can be little doubt that to that close touch between indoors and out, to that absence of domestic comfort, is owing the preservation of national hardihood; while we must remember that it is from these

old homes of England that has come a race of workers who have borne for some 600 years the burden of England's greatness, finishing patiently and perfectly the work they understood, and without which no nation could exist.

Take this account from Richard Jefferies of one of these workers:—

"A tall, big man, every inch of his frame had been slowly welded together by this ceaseless work —continual life in the open air and coarse, hard food. This is what makes a man hardy. This is what makes a man able to stand almost anything, and gives a power of endurance that can never be attained by any amount of gymnastic training.

"His food was dry bread for the most part and a little lard.

"I used to watch him mowing, with amazement. Sometimes he would begin at half-past two in the morning and continue till night, taking only a short rest on some dried herbage under a tree at midday."

In thinking of the outdoor workers' attitude towards a cottage of this kind, I always call to mind the words of an old carter I once knew in Surrey. We were talking about two old men, well known in all that county (one was called "Uncle" and the other "Teapot"—I never heard any other name for them), men whom we should call tramps, but whom I always found ready to be helpful if wanted. I asked him where they lived, for I had seen them at tea in a neighbouring ditch that afternoon with a kind of tent thrown over the hedge to protect their fire. He answered, "Oh, they never use no houses, you know." Before that I had never thought of a house as a small object to "use," and I felt the precarious nature of a cottager's life in a new way.

Most old houses had no foundations, and none of them any damp course. They were put straight upon the clean earth. I like to think of great buildings and cathedrals in that way—built on clean and sweet soil with no complications of underground pipes and heating apparatus. Do you remember the tale of the Epping Forest gipsy? His life was at its ebb, but he could not make the change inside the caravan amidst all its needless humanities. "Put me out on the turf," he said, and they laid him on the fresh green grass, and he died—took fresh breath for new adventures. In men and buildings there is the same ineradicable tendency and influence to fetch back to origins. It is there we can die and revive rationally with better powers for better work. And we English are not come of thralls or the worthless, but were born of a fearless and hardy folk, and it is surely our great privilege that we may still, if we will, read the very handwriting of their strength and hardihood. In the work they left us we can truly see what kind of a folk they were, and now after that early edge of life has got somewhat dulled, learn a little of their wisdom and outlook upon land that had as yet seen nothing of coal smoke or machinery.

As to the present condition and standards of comfort or discomfort we find to-day in ancient cottages we must in our judgment of them be careful to be just.

Professor Geddes once showed me a plan—a regional survey of Salisbury—which made it clear that the mediæval town had been set out on broad and sensible lines with quadrangles of houses, straight streets, and square "places"—a city with abundant gardens and fresh air. This plan and early thoughtfulness for the health and service of the people has been (mostly during the last 150 years) completely overridden by allowing thoughtless, or perhaps too thoughtful, persons to fill up the old spaces and gardens with rent-paying tenements that very quickly degenerated into slum areas; the point being that the mediæval plan was a healthy and sensible one and we spoilt it. Similarly, after the open galleries and staircases that abounded in the backs of old Edinburgh houses had been closed in by order of the medical officers, a great increase in serious illness was noticed. The enforced work in the open air, the domestic discomfort as we find it, tended to healthy life.

Our ancient cottages and farm-houses were seldom more than one room thick—strongly built but primitive dwellings—built for use rather than enjoyment, for shelter from the worst of the weather, and only gradually becoming the homes of men and women to whom life and work were *one thing* and the house, at first, only a convenience for carrying on that work.

The development of these old cottages, by what we will call supplementary modern requirements added from time to time, has in most cases obscured the original form and arrangement—which was, generally speaking, simple and spacious and peculiarly fitted for its purpose. This development has been allowed to go on in a haphazard way until we often find cottages that once had ample room and great manners divided and sub-divided into inconvenient little places with dark corners and stuffy chambers, making the mere labour involved in keeping up a moderate standard of cleanliness more than any busy woman has the heart to

face. The so-called progress of civilisation, acting upon imitative ignorance, has encouraged this complication, this spoiling of a good original, and made opportunities for illness and brought about many unnecessary problems.

The first modern requirement with regard to ancient cottages seems to me therefore to be education, both for the users of them and for ourselves. For them that they come to see a better form for their own lives; for us, well, not much more than that we help them by removing some of their difficulties. This may well include a general tidying up of the old dwelling-place, but it ought also to enable us to see that they are manifestations of a great period of English building and craftsmanship. The ignorance and apathy of authority with regard to them is a serious matter, and from this side their greatest danger. In its present unorganised state neither study of history nor expert knowledge of building has weight against the word of any medical officer whose entirely honest judgment is often as entirely a mistaken one.

Of the proper treatment of old cottages with a view to their re-use under improved conditions, it is only possible to speak generally. The particular construction and condition of each house must suggest the treatment desirable. No old cottage need be condemned to destruction that has its outer shell still in fair condition. It will be cheaper to mend it and re-cast the interior than to build a new one. The first thing to do is to get it examined thoroughly, to find out the cause of its disorder—and there is a very widespread disorder that is common to all and has been the chief cause of dilapidation, illness and expense, and that is the inefficient disposal of rain-water from the roofs, and the consequent soakage of the ground. We have seen that most cottages, and indeed most ancient buildings, have no foundations and no damp-proof courses, and though originally perhaps that was no disability, yet surface soakage will let down any wall in time by softening the once firm ground, and the slow disintegration of the lower parts of the wall. Foundations and damp courses are I think both much over-rated, and could in a great many cases be safely dispensed with, provided proper attention is given to surface drainage. In many stone-built houses—for example, in Rutland, Northamptonshire, Gloucestershire, and Wiltshire—the stones were bedded in the ordinary soil of the district, and not intended to resist this continual soakage, as is often seen by the sheathing of the wall bases with large flat stones, and by the rough stone drainage which is a common plan with Gloucestershire builders. A damp course in such buildings merely serves to retain accidental moisture. These points, in a stone or brick building, should be the first seen to, indeed, it ought to be the common practice of all owners of cottages to have this vital work kept regularly in order. This might lead some day to rain-water storage tanks.

In timber buildings the usual plan was to lay balks of oak along the ground for a foundation, sometimes on mason or brick work, sometimes not, and these, of course, are greatly damaged by continued neglect of the surface drainage. But here again the remedy is a simple one, and if the foundation timbers are past work new ones should be inserted to take the uprights as before. I daresay many of you have noticed, in Surrey and Sussex cottages, a wedge-shaped cut some six or seven feet from the ground, in the vertical timbers of the wall frame. These were made to take shoring pieces, and I know a man who had often used this method of holding up the framing while a new footing to the wall was being inserted. That is part of the common tradition of timber house building in the South of England. When a stone or brick building has become cast, or out of the upright, it has often been found a simple matter to push it into the vertical again with shores and wedges. If it is a timber building that has gone over, it will generally be enough to strengthen the joints in all the vital parts of its construction with iron straps. The chances are that it will have taken its new bearings, and any attempt to restore its verticality will be hurtful. Having made sure of the walls in this way quite half the problem of repair is solved. The next most important step is to get the roof right. The rest can then follow at your leisure. In certain cases mortices may be lengthened to allow non-uprights to be moved along in them —repinned—and the old mortice filled in. In examining oak roofs, or in some cases roofs of fir, the timbers will be perished on the surface and quite sound otherwise and in no need of renewal. I have seen old roofs pulled down whose timbers would have lasted another 100 years at least if kept dry. Supposing the bedrooms are too low—and there are possibilities in low rooms that at first sight may appear untenantable—if rooms are too low it is often quite easy to raise the entire roof without removing a rafter, by

jacking it up slowly with a number of jacks placed so as to take the weight at the constructional points. For this purpose it is only necessary to have raking shores, loose at the bottom end and attached to the wall-plate, so that with each screwing of the jacks the shores also rise and can be wedged, thus avoiding any risk of collapse. If the lower rooms are too low, the small timbers of the floor can be cut off at the wall face, a slot made in the wall to let the main beam move upwards, and beam and floor raised together. Then fill in your walling below the two ends of the beam and lay a wall-piece across to take the ends of the shortened joists.

For damp floors of earth or stone the remedy depends on the kind of new floor to be used. Solid floors are best made dry by a thick layer of dry, broken rubbish covered with 2 or 3 in. of cement concrete; even a running stream will then not affect the finished surface, which may be of boards laid solid in mastic, or of tiles or stone laid in cement or sand.

Generally speaking, all by-laws should be got out of the way in favour of local common-sense, and then difficulties can become interesting, and their solution easy and entertaining. In all such work an old building deserves to be treated with all available respect, such as the use of oak to repair an oak frame—or an oak floor—the use of stone lintels in a stone house rather than concrete, and so on.

Another point in which we can do honour to an ancient building is a more difficult one to come by, and that is to see that the work done in repairing is well finished. We find workmen now cannot understand true finish. A bad piece of work well sand-papered or puttied up is for them "finished," except in rare cases in the more out of the way parts of the country where good habits still prevail—whereas true finish is just true finish. It has long been a joke against stonemasons—a joke only understood by architects and not by all of them—that stonework is only finished after it has been dragged to a perfectly smooth surface, and if asked to finish otherwise, viz., with a boasting chisel, they will spoil that surface afterwards to suit the taste of those who wish it so left from the chisel. Both, in their proper places, can be true finish, but not both at once; and while the finest surface may be desirable on a door-jamb or chimney opening it is obviously unnecessary on a tower or external walling. For the rest of our repaired cottage we have windows and doors to see to and plastered walls and ceilings. Many windows seem too small that become large enough when made to open; in bedrooms it is generally an easy matter to add dormers or heighten tiny windows without any damage to the proportions of the house—but it must be done from the house's point of view and not a mere cold insertion of a ready-made window. Downstair windows where the rooms are seven feet high can be safely taken up to within a few inches of the ceiling.

Where a cottage possesses any remarkable feature, such as a mediæval window frame, with stone or wooden moulded mullions, it is better to introduce a new window altogether and leave the old alone after due mending.

For new out-buildings, use local materials and if possible local workmen, weather boards, cob, rough walling, thatch or tiles as in the main house; but the work should be done well, well planned and well finished, for it is in the completeness of ancient work that so much of its character lies. We are too apt to slur over our building work, to "fling houses together," as some have dubbed it, a practice that greatly impoverishes the English landscape—makes it look thin and weak.

It is not enough to accept wages. We need more, as an American has told us, to accept the challenge of life to reveal our full powers and to desire opportunity to make the proof. Still there are those yet living who have not abandoned the better way; slowly and with protest they are forced to give up what they know to be right, yet holding in their hands the accumulated traditions of all great handiwork. The mere enumeration for example of the things known to a farm labourer would put to shame, in its comparative effectiveness, much of our higher education. To him we owe the well agriculturalised country side, the hedging and ditching, the cleanings and burnings, the furrowing of the land, the placing of ricks and their building. He knows the times for all these things and they are familiar to him. Or take the woodmen and their various knowledge, or the wheelwrights, the hurdle makers, the thatchers, we accept all these; not greatly caring if they persist or cease, and taking little thought for their decent housing.

And yet you cannot work with these people without finding in them unexpected wisdom of all kinds, but especially work wisdom—all the first steps as well as the matured knowledge seem fresh and new, and their readiness to impart it is only hindered by the awkwardness

of speech. One will tell you the proper wood to use for an axe handle, another will tell you how to sharpen and set a saw so that a needle can run along the teeth of it, how to test the steel of it by making it sing as he strikes it with his finger tips.

My plea for ancient cottages is bound up with the thought that they are the places where England was made, the homes of all country handicrafts the explanation and the history of the people, an object lesson for our own time in simplicity of life and straightforward building that has been the basis of England and English life through so many centuries. It is surely no small part of English history that here in these humble dwellings has grown up the knowledge of all agriculture and all building. No one can say from what remote antiquity this knowledge came, but we need to remember that it was only serviceable to workers, in their doing of work, only indeed comprehensible to them as rules of work.

DISCUSSION.

THE CHAIRMAN (The Right Hon. Earl Ferrers) said the paper had been a most stimulating one on the human side of old buildings, and probably a good many of those present very much enjoyed having the subject presented to them in words which few could have chosen as well as the author, because he really did fundamentally sympathise with old country life and its traditions, of which ancient cottages were a visible sign. Besides being that, they were in a way a crystallisation of an old type of life through which one could read a bountiful amount of the past with sympathy. At the present time history was very much valued, and our modern idea of history was a history of people and not merely a history of dates and battles and kings, or even of constitutional movements. Our interest in history was fundamentally from the point of view of the people and the community, just as our interest in art was centred in the school of painting rather than in the individual artist. Therefore the present was certainly not the time to throw away the whole of the extraordinarily interesting and charming evidence we possessed on the fascinating subject of the life of our forefathers.

MR. BERNARD SHAW said that it must strike Mr. Powell as very odd that when he, skilled as he was not only in building but in all the domestic crafts associated with building, had told the audience all he knew on this highly technical subject, the first invitation to speak should be addressed to a literary man who obviously knew nothing whatever about them. He was not sure that a great deal of mischief had not been done within his own lifetime by building which was purely literary and nothing else. He had lived in some literary buildings, and had felt intensely relieved to go back to an eighteenth century house, a sensible sort of house made by simply putting a number of rooms together and making a passage by which to enter them. The literary and artistic house—a place where everything was made as dark as possible, where there were as few windows as possible, and as much of those windows as possible was filled up with lead—in which one lived with an exalted sense of its artistic qualities, was really a sort of architectural hell.' He had come to the conclusion that what is wanted is a law that every building in this country shall be knocked down at the end of twenty years and a new one erected in its place. Of course that would get rid of the old cottages; but what right had the people of this country to possess old cottages? One of the reasons why so much of our building work was bad was that we had got into the habit of sponging on the past. People made a tremendous fuss during the war about the destruction of cathedrals, such as Rheims Cathedral; but in a competent state of the arts and crafts the sensible thing would be to get a new cathedral and new stained glass, and do the whole thing over again, and see if it could not be done better. If we were a genuinely active people, producing decent habitations and decent art, it would be very hard for an old building to keep alive. An architect in the fourteenth or fifteenth century regarded a Norman cathedral simply as a building out of which he could hew something perfectly new. Personally, he had all his life had the feeling that every generation ought to be able to produce its own art, and that the worship of the past that people of the present day had been driven into was a diseas that could be cured only by the wholesale destruction of all the monuments of the past, so as to force us by a kind of starvation to produce our own art. People tolerated ugly buildings and ugly surroundings, and then during their holidays went to look at a beautiful old house as something unique. It was certainly pleasant to look at some old English villages and cottages; but what a horrible thing it was that a pretty cottage or village should be a spectacle which people travelled a long distance to see! It ought to be a matter of course, so that no single person in the country should look twice at a decent cottage. If the wholesale destruction of human beings involved by a war could be avoided, he would be glad to have half a dozen wars, so that all old buildings could be destroyed and replaced by new and perhaps better ones.

MR. H. H. STATHAM, F.R.I.B.A., said he had listened to the paper with great pleasure, and he thought one very important point made by the author was that the old cottages he described were not only buildings but homes. He did not agree with the author about the unimportance of foundations. Mr. Powell liked to see the stone work put on the clean earth. That was done with the front of Peterborough Cathedral, and the result

was that enormous expense had to be incurred to straighten it again. He thought the smallest cottage would be better for a good foundation which could be trusted not to give way.

The Author, interposing, said he believed the foundations of Peterborough Cathedral were about ten feet deep, being placed on faggots on the marsh, and proved inadequate only because the marsh was drained.

Mr. Statham, continuing, said that he thought mediæval builders did not trouble themselves very much about foundations. A great many old cottages had very small windows, which looked very pretty but which were unhygienic, and in the garden cities at Letchworth and Hampstead the houses were also built with very small windows, simply because the ancient cottages had them. He thought that was a great mistake. Then again, ancient cottages had very high roofs, which looked very picturesque, but they were built in that way chiefly because mediæval carpenters had not acquired dexterity in building low-pitched roofs. In these days of concrete he did not know why pitched roofs should be built at all. They need only be steep enough just to throw off the water. People thought that flat roofs were not picturesque, but if one looked at a photograph of an Eastern town it would be seen that all the roofs were flat and yet the place looked picturesque. It was only a matter of association. The old cottages were very deficient in any provision for cleanliness. One of the things people were being encouraged to do now was to have some corner in the cottage where they could put a bath, but that was never thought of in the Middle Ages. With reference to the remarks that had been made about the academic and uninteresting character of modern architecture, he thought that could be got over if people who built cottages would not try to imitate the old ones but would simply consider how they could produce the most convenient and the most lasting building with the materials which were most in use at the present day. Cottages would then be built which would have quite a different character from the old ones, but would have a character of their own, and in time people would become as fond of them as they were now of the ancient cottages.

Mr. Maurice B. Adams, F.R.I.B.A., thought the meeting owed a deep debt of gratitude to the author for the tender way in which he had dealt with the subject. The aspect of the matter put forward by Mr. Shaw was impossible if a satisfactory solution of the problem was to be attained. The delightful way in which Mr. Shaw destroyed everything that he approached was quite startling, but, although underneath it all there was a great deal of stern sense and appropriateness, the object of the paper was surely to ascertain as nearly as possible how the delightful old buildings existing in the country could be utilised to assist in solving the problem of housing the people, and how they could be preserved also on account of their historical character and their artistic merits. He did not think Mr. Shaw would really like to see the delightful old cottages and wayside dwellings in this country pulled down. The business of architects was to deal most tenderly with them, and to prevent the local surveyors and local district councils destroying their artistic features in an attempt to make them habitable. With reference to Mr. Statham's remarks about the advisability of building houses with flat roofs, it must be remembered that the climate of England was very different from that of the East, and the old houses in this country had steep rooofs to protect them from the rain. There was no doubt that in building new houses the roof must be considered from an entirely different standpoint from that adopted by the old builders; there must be no wasted space inside the building caused by steep roofs, but he hoped that flat ones would not be adopted. The logical thing to do was to build a concrete house in the form of an ellipse and utilise every cubic foot that was enclosed. That would be a radical enough innovation to please Mr. Shaw, because there were no houses built on that plan, at any rate in this country, and there were very few elliptical buildings in the world, because they could not be constructed in masonry but must be monolithic structures. The principle was the same as that of the construction of an egg. An egg was so strong that it could not be crushed in the hand except by the exercise of a great deal of pressure. But whether the new houses were built of concrete or wood or anything else, the old houses which existed at the present time had to be considered, and if the Royal Society of Arts and the Society for the Protection of Ancient Buildings, and everybody else who had any regard for the beauty and value of ancient cottages, would use their influence and show how those buildings could be made habitable and healthy to live in, so much the better. In the last ten years he had noticed in the press and elsewhere a much more intelligent view being taken of the value of old houses, and he thought also that the public were beginning to realise the commercial value of a good piece of architecture. Until a few years ago that was an idea that had never struck anybody. Those who took an interest in ancient buildings had a duty to perform to the public at the present time, and also, as the author pointed out, to those who were to come. The buildings ought to be preserved for those who were to come as much as for those living to-day, and he thought the paper would very materially help in that direction. He had hoped that the author would exhibit some lantern-slides showing some old buildings in process of being dealt with. It was, of course, a very risky thing to lift the roof of an old building. It was true that in Stuart times and in times previous to that the roofs were extremely low. In some old Stuart cottages in Sussex that he had had to deal with the only thing he could do was to lower the floors. But so long as the rooms

were eight foot high he thought that was quite sufficient. In Victorian days twelve foot was considered the proper height for a room in a villa, but if one could stand upright with comfort in a room he did not think its height was of very much importance. The Ministry of Health had put forward a most admirable schedule of heights of rooms, cubical contents, size of windows, and so on, but they had come down from that to approve of some of the worst plans for building houses that could possibly be conceived. He had seen some plans published recently which contravened every rule that the Ministry of Health had laid down as a guide to new buildings, and yet it was said that those plans had received the approval of the Ministry of Health. In conclusion he wished to emphasise the point that whatever was done to ancient buildings they should always be treated in the most tender and loving way.

MR. A. R. POWYS (Secretary of the Society for the Protection of Ancient Buildings) wished to thank the author very much for his interesting paper, which he had listened to with great pleasure. He thought the practical question to be considered now was what was going to be done to keep the old cottages that were so much appreciated at the present day. They could be made use of by being adapted inside, possibly by having their floors lowered, as had been suggested. He thought, however, that many rooms would be sufficiently high at 7 ft. 6 in. One of the reasons for having a low room was that it could be more conveniently warmed. In some places the inhabitants of the cottages had considerable difficulty in obtaining fuel, and, therefore, low rooms, provided they were sufficiently high to stand up in, were an advantage. The reason why cottages were becoming so dilapidated at the present time was first the neglect from which they had suffered before the war, and, secondly, the very much accentuated neglect from which they had suffered during the war. He did not think new houses would be built sufficiently fast for the old ones to become entirely superfluous at present, but as the new houses were being built the old ones were not receiving the attention they deserved, and by the time the new ones were finished the old ones would be in such a state that it would be very much more expensive and difficult to repair them than it was now. It was necessary to impress upon people that it was as important to repair the old cottages as it was to build new ones, and more economical at the present time. A great many mistakes were commonly made in the process of repair, and it was the object of the Society for the Protection of Ancient Buildings to try to help people to do the work in the right way and to show them the lines on which they should carry out the repairs. His Society had published a pamphlet on the repair of cottages, but they had not yet had a concrete case. At the present time, however, they knew of a cottage in a dilapidated condition which they could purchase for the very small sum of £20, and they wished to buy that cottage and repair it. The cost of repairing it and making it suitable for modern conditions would be from £200 to £300 or £325, which was really a very small sum to collect. They then proposed to use the cottage as a sample and produce another pamphlet with photographs of the work going on, and they would then distribute the pamphlets broadcast throughout the country as a guide to district councils. He wanted to say a word in favour of district councils, which were at the present time in an extraordinarily difficult position. Many of their surveyors had not been trained to appreciate the craftsmanship and the great value of early buildings. Many people understood to a certain extent the value of old furniture and pictures, because they could collect them in their houses, but they did not appreciate the value of ancient buildings simply because they could not collect them. He thought district councils were willing and anxious to do the work in the right way and did not want to be obstructive. All their officials that he had met expressed themselves as most anxious to preserve and make use of old cottages, but it appeared they did not know exactly how it should be done, and the Society for the Protection of Ancient Buildings wanted to show them how to carry out the work. He therefore asked those present to send subscriptions to the Society so that a concrete example could be furnished. He added that his society was willing to give lectures on the subject throughout the country, and that these lectures would be far more valuable were they to include a series of lantern-slides showing the work in progress.

MR. HALSEY RICARDO, F.R.I.B.A., said he would like to ask Mr. Bernard Shaw how far he would carry his destructive process throughout the arts, and whether he would destroy literature and poetry as well as buildings. As a matter of fact we were saturated with the past, and he did not think Mr. Shaw's remarks expressed his real feelings on the subject. With reference to the cottage which Mr. Powys said he could buy for £20, and which would cost about £200 or £300 to repair, if the proposition was only viewed from a commercial standpoint it ought to appeal to everyone, as a cottage could not be built at the present time under £800. He hoped that the synthetic way of planning houses in quadrangles, mentioned by the author, might be revived. There was probably a much stronger communal feeling now than there was before the war, and he trusted that feeling would grow, and that people would realise that their strength did not lie in individualism, but that they were the cells of the body politic, and it was their duty to co-operate with one another. The scattered habitations in villages were one of the causes of the dulness of life in rural districts, and on hygienic grounds there might with advantage be more grouping of cottages. If they were built in quadrangles fairly near together it would be a simple matter to have communal washhouses, heating, and lighting. A

proper system of lighting was very much needed in villages, the darkness of which at the present time was very trying to men and women who had finished their work by sundown. He thought there was a great deal to be done in the way of education. The cottage of the present day was a much more scientific affair than the cottage of the past, and people should be instructed as to how to use it. The children in the schools should be taught about drainage, ventilation, heating, and so on, and the medical officer of health should visit the schools occasionally to see that the teaching was kept up. With regard to the question of finish, which was mentioned in the paper, the beauty of finish was really a moral quality, and was the expression of a man's pleasure in what he was doing. The value of finish was the endurance it provided. If a cottage was built that was not going to last very long, the various small parts would give way much too soon and disintegrate, and the building would be a ruin long before it should be. In conclusion, he wished to emphasise that the main question was that of education in the villages, and that the young should be taught that they were members of a very large social organism and must play their part in it.

Mr. E. Howard Wilkins thought some of those present were perhaps a little disappointed that the author had not dealt more fully with the practical side of the restoration of ancient cottages. He was very much surprised to hear Mr. Powys say that the Society for the Protection of Ancient Buildings had not yet been able to obtain an example of the restoration of an old cottage in progress and was now seeking to purchase an ancient cottage for that purpose. Personally he had had a considerable amount of practical experience in connection with the matter. In 1913 he acquired two fishermen's cottages in a Sussex village which were in such a dilapidated condition that the local authority contemplated closing them. Much of the work he had had to do on the cottages had been mentioned by the author, for instance, the question of foundations and damp. He found that a very simple method of dealing with that was to dig a trench all round the foundations a foot deep and cement the wall with about 1½ inches of cement concrete a foot below the ground and 9 inches above. That had a very good effect, especially the part which was above the ground, because the cottages were thatched, and a thatched roof where the thatch extended generally about 3 ft. from the wall in its overhang had got no gutter. A gutter was not required, but of course the rain dripped off the roof on to the ground round the wall of the cottage. The way to deal with that was very simple. He purchased from a contractor who had been demolishing the General Post Office a large quantity of broken stones, which he laid together all round the cottage for a distance of about four feet. That took the drip from the thatch, and the cottage, which was formerly damp, was now quite dry. He was sorry the author had not mentioned what his view was on the subject of thatch in restoring ancient cottages. When he examined the roofs of the cottages he had alluded to, he found that many of the rafters were broken and pinned in, it being the custom in re-thatching buildings to put the new thatch on the top of the old. He fixed up a framework inside the roof and strutted it out and put in new rafters in place of the broken ones. When he had restored the cottages his friends were so struck with them that they all wanted to buy old cottages and restore them. One gentleman came down from London and purchased eight old brick cottages, in an L-shaped block, for £225. They were five-roomed cottages, with lofts, and were so dilapidated that they were about to be condemned by the local authority, but they had now been restored and made habitable, and some of them were let furnished to-day for £2 10s. a week. In the restoration of such cottages difficulty was often experienced with the local authority, as, for instance, in the matter of thatching. It was said that thatching was dangerous from the point of view of fire, and it was true that cottages in rows or standing close together should not be thatched, but where they were detached there was no better form of roof for a cottage than thatch, which was warm in winter and cool in summer. The walls of the cottages in Sussex that he had restored were very massive, being composed of solid boulders 18 inches round, the spaces between them being filled in with smaller stones and cement. In order to make the corners square the builders had used any pieces of square stone they could find, and from one of these he had been able to tell the approximate date of the cottage, because it consisted of a tombstone bearing the inscription "Here lieth the body of James Bell," and a date of the seventeenth century.

The Chairman, in proposing a vote of thanks to the author for his interesting paper, said the question dealt with was a very practical one. There were many cottages all over the country which were threatened with demolition, and he did not think it was generally realised how difficult the circumstances were for the owners of the cottages. In the first place there was pressure put upon them on the subject of damp courses, height of rooms, and other matters connected with hygiene, and in the second place there was the fact that the cost of restoration was at least three times as great as it was before the war, and that, owing to all patriotic people having done as little as possible in the way of building during the war, and not being able to get the bricklayers if they wanted to do it, many of the cottages were in a very bad state of repair. The owners had got to make good the four or five years of arrears in the upkeep of the cottages, and they had to do it at three times the former cost. That was a rather serious matter, especially in connection with country cottages, which were often let at a rent of

1s. or 1s. 6d. a week, and made it extremely difficult for the owner, whose income from the cottages probably entirely disappeared and left a considerable deficit. At the present time the owner was not allowed to raise the rent to recoup himself, except under certain special conditions. That was rather unfortunate, because the community wanted the cottages, and it fell to a number of individuals, some of whom simply could not afford it, to repair them for the community at their own expense. It would be very useful if the owners could be helped in any practical way, such as that which the Society for the Protection of Ancient Buildings proposed, *i.e.* to organise advice as to the repair of cottages and to publish pamphlets, etc. Mr. Bernard Shaw, the destroyer, and Mr. Powell, the preserver, were in a way very much akin, because they both looked at the matter from the human end. Mr. Shaw's remarks were simply a paradox by which he wished to emphasise that we had got to do really good work at the present day. The moral of most of the remarks that had been made at the meeting was that a cottage was a good thing and a fine thing when it started at the human end. If a man tried to build something which was artistic, he only produced something artistic, and it had no really permanent value about it at all; but if he started at the human end, and his aim was first and foremost to make a home for a person who deserved one, he would make a really good home. The difficulty at the present day was that the people for whom cottages were being built did not take sufficient interest in the matter to insist on really good homes being built for them. When the ideals of the people were set right and they began to take an interest in the houses they lived in, that state of affairs would be altered.

The resolution of thanks was carried unanimously.

Mr. Powell, in reply, said that in regard to thatching he had always noticed that in England when a roof was being re-thatched the new thatch was put on the top of the old, but in Holland, where he had been during the war, he found that the farmers, who did the work themselves, pulled the thatch right off down to the rafters and started again. As to the inflammable nature of thatch, he remembered a blacksmith's shop on the common at a village near Cambridge, which he was told had never been re-thatched for seventy years, and as he stood near it he saw the sparks were falling in thousands all over it. The secret of that was that the reeds composing it were placed so that there was about one-eighth inch or quarter inch space left at the end, instead of the straws projecting about six inches on the outside, as was generally the case.

The meeting then terminated.

INDIAN INDUSTRIAL DEVELOPMENT.

After considering the views of the Government of India on the report of the above Commission, the Secretary of State, Mr. Montagu, recently wrote a despatch, which has been published in India. He accepts two fundamental principles underlying the recommendations of the Commission. First, that in future Government should play an active part in the industrial development of the country; secondly, that Government cannot undertake the work unless provided with adequate administrative equipment, and unless forearmed with reliable scientific and technical advice. He agrees that suitably equipped organisations should be set up in the Provincial Governments and in the Central Government. In giving effect to this policy, he continues, State assistance will take various forms, such as research, the survey of natural resources, technical and scientific advice, educational facilities, commercial and industrial intelligence, the establishment of pioneering and demonstration factories, financial help, the purchase of Government stores in India, and probably also fiscal measures. He points out that if development is to proceed on sound lines labour must be made more efficient. He notes that the Government of India are not yet prepared to formulate proposals regarding the organisation of the Imperial Department of Industries, but contemplate setting up as an interim authority a Board of Industries and Munitions which would close the war commitments of the Indian Munitions Board taken over from the Commerce and Industries Departments.

In a "resolution" simultaneously issued the Government of India state that they are arranging to constitute committees to deal with the creation of a Chemical Service and of an Indian Stores Department. They have also ordered the reconstitution of the Indian Munitions Board as a Board of Industries and Munitions.

COTTON-GROWING IN ANDALUSIA.

The fact that Spain has begun to realise its economic dependence on foreign countries, and feels that the United States will probably need all its raw cotton for home consumption in textiles, has resulted in the appointment of a Commission which was sent to Andalusia by the Catalan Cotton Committee to investigate the experiments in cotton-growing that have been made in Jerez, Malaga, Murcia, Valencia, and the province of Seville, and to determine the possibility of raising the plant successfully on Spanish soil.

The report of this Commission, writes the United States Consul at Seville, is extremely encouraging. Experiments show that the soil of Andalusia is admirably adapted to cotton-raising, and that, in addition to the land already prepared for other crops such as cereals and vegetables, vast swamps could be reclaimed and utilised for this purpose. It is claimed that one hectare (2·47 acres)

of land will produce 500 kilogs (1,102 lb.) of cotton, and that enough cotton to supply the Spanish market could be raised on 200,000 hectares. This product, the experiments indicate, would be equal in quality to that grown in the United States, although measures would have to be taken to protect the crop from the heavy rains in the autumn.

The farmers are being instructed in the raising of the plant, and the Catalan mill-owners, in whose mills most of the imported cotton is worked into textiles, will assure them a ready market. Agriculturists in the Seville district are showing great interest in the project, and are co-operating enthusiastically with the Catalan Committee.

With regard to the reclaiming of swamp land for the raising of cotton, a movement is on foot under Government control and support to drain the land on the left bank of the Guadalquiver River near its mouth, thereby reclaiming some 37,000 hectares (91,429 acres). This extensive tract comprises the districts lying between Los Palacios, Villafranca, Las Cabezas de San Juan, Lebrija, Trebujena, Sanlucar de Barrameda, and Jerez de la Fronterà. Preliminary surveys have been made, and it is estimated that eight years will be needed to complete the work and an additional two years to free the soil from salt. On account of the annual overflow of the Guadalquiver River, extensive measures will be necessary to provide against floods. An exhaustive study of this problem, extending over a period of two years, has been made by Government engineers, and it is felt that the need of land for cotton-growing will give an added impetus to the Government's plans for reclaiming the district.

COCOA PRODUCTION.

The following notes on the preparation of cocoa beans have been issued by Mr. W. H. Johnson, Director of Agriculture, Ibadan, Southern Provinces, Nigeria :—

Now that the time for the cocoa harvest is approaching, it behoves all those persons who are interested in the rapidly increasing trade in this important staple to encourage the growers to market the crop in the best possible condition. Although the practice of fermenting the beans is much more generally adopted than hitherto, a great deal of the crop is still marketed in an unfermented, or very slightly fermented, condition. The variety of cocoa grown in Nigeria is the same as that grown in Cameroons, yet Cameroons cocoa almost invariably realises about 10*s*. more per cwt. than Nigerian cocoa, simply because it is more carefully cultivated and cured.

Experiments, spread over a period of four years (1912-1916), which were conducted by the Agricultural Department at Agege, amply demonstrated that both the yield and quality of Nigerian cocoa can be greatly improved by adopting better cultural methods and by more careful preparation of the beans. Samples of the cocoa cured during the course of these experiments were reported by the Imperial Institute to be worth 77*s*. to 79*s*. per cwt. at a time that Cameroons cocoa was selling at 74*s*. to 76*s*. 6*d*. per cwt.

Cocoa manufacturers prefer large, plump beans, not only because they have a lower percentage of shell than small beans, but because this appearance indicates that the cocoa has been well grown and harvested when it was properly ripe. Neglected and unhealthy cocoa trees produce undersized pods with small, flat, badly-filled beans. Cocoa beans which are harvested before they are properly ripe do not ferment normally; they have a flat, shrivelled appearance after being cured, and the farmer loses weight by harvesting them. On the other hand, over-ripe beans produce an inferior quality of cocoa; moreover, they may have commenced to germinate, and as a result the germ makes a hole in the shell which affords free access to mould and insects. In the preparation of cocoa powder, germinated beans develop an objectionable flavour and odour, so that manufacturers regard them with intense disfavour. Although less prevalent than hitherto, the practice of washing the beans before drying them is still continued in some districts. This operation is not necessary; it may improve the external appearance of the beans, but it reduces their weight and makes the shell thinner and more susceptible to breakage and insect attack.

The fermentation process performs several useful functions; it removes the sweet pulpy tissue in which the beans are enveloped, and it alters their chemical composition. The bitter taste of the fresh beans is lessened, the peculiar chocolate aroma is developed, the tonic and stimulating principles are liberated, the colour is altered from violet to brown, while the kernel is loosened from its shell and more readily crumbles up when subjected to light pressure. A certain amount of weight is lost during fermentation, but fermented cocoa dries more rapidly than unfermented cocoa.

The period of fermentation necessary is not only dependent upon the variety of cocoa under treatment, but upon climatic conditions as well. Varieties such as Criollo, which produce light-coloured and mild-flavoured beans, require far less fermentation than the bitter-flavoured, violet-coloured beans of the Amelonado variety, which is grown in this country. Fermentation changes take place more rapidly when the weather is hot and moist than when it is dry and cool.

It has been found that Nigerian cocoa generally requires to be fermented for about six days. If, after fermentation, traces of the violet colour are found within the kernel, this is an indication that the period of fermentation has not been sufficiently prolonged. Convenient receptacles in which to ferment the beans are boxes made of Iroko or other durable wood fitted with a movable bottom perforated with holes. The seeds from about 5,000 pods should be placed in one box, and they should be lightly covered with banana leaves; the following

day they should be turned into a second box and thoroughly mixed together during this operation. It will then be observed that the temperature of the beans has risen, but that it is higher in the beans which are best aerated, *i.e.* those situated near the top and the bottom of the box. In order to ensure a uniform fermentation throughout the mass, it is necessary to mix the beans thoroughly and turn them into another box each day. As fermentation proceeds, the pulpy tissue liquefies; to allow this to escape readily the perforations in the bottom of the box are made. If this liquid is allowed to stagnate at the bottom of the box it discolours the beans and injures their flavour. On the morning of the seventh day the beans should be ready for drying. Over-fermentation must be guarded against; the appearance of brownish spots on the seeds is an indication that the time has arrived for them to be dried. They should be spread out thinly on a clean, dry surface, preferably raised above the ground. Drying is facilitated by turning them occasionally so as to expose all sides of the beans to the sun. The "kernels" of properly cured beans may be readily broken up into flakes when lightly pressed between the finger and thumb; they have a sweet chocolate flavour and a brown colour. The external appearance of the beans is improved by rubbing them with the hands before they are dry; this operation imparts a gloss to the shell. During very hot weather it is advisable to pile the moist beans into heaps for two or three hours during the hottest part of the day; if this practice is not followed, the shell is liable to shrivel and assume a brittle consistency, which is readily fractured. All small, shrivelled, and broken beans should be picked out and sold as inferior quality cocoa.

It is important to keep not only the cocoa, but also the vicinity in which it is prepared and stored, in a sanitary condition, for the exposure of cocoa to bad odours is often responsible for that objectionable flavour which it develops in the factory on being roasted, and is described in the trade as "hammy."

THE CORK INDUSTRY IN SARDINIA.

Cork trees are indigenous to Sardinia, and extensive natural forests are to be found upon the mountain slopes in the northern part of the island. The crop is cut every nine years—that is to say, a tree stripped of its bark last season will be left untouched until 1928.

According to a report by the United States Commercial Attaché at Rome, the cork industry is in a flourishing condition, large profits having been made during the war. A large factory at Tempio has recently increased its output to four times its former capacity.

The process of industrial production, as employed in the Tempio factory, is comparatively simple. The dried out bark in its cylindrical form is first thoroughly steamed and flattened out under pressure. It remains in piles for about thirty days and reappears covered with blue mould. The bark is then carefully scraped on both sides and cut into strips corresponding in width to the varying lengths of the cork stoppers desired. These strips are cut by hand into cubes. This process calls for highly skilled labour and an apprenticeship of at least four years.

The cork strips are full of defects, and it requires a skilled hand and eye to secure from the cork the maximum of merchantable material. The cork cubes are put through high-speed finishing machines, which round off the edges and give the required taper. This cutting process involves a waste of 20 per cent., and is being superseded by an abrasive process which wastes less than 3 per cent. The fine cork dust, which is a by-product of the abrasive process, found a ready market in Germany before the war at from 40 to 45 marks per quintal (approximately £20 per ton). The precise use the Germans found for this cork dust is not known to the Sardinian producers.

At Terranova cork is prepared in other forms for export. The best cork is baled in sheets for shipment. The inferior cork is ground to a coarse dust and employed with a magnesium surface finish for sound-proof walls and floor coverings. The war stimulated the cork business principally through the demand for trench mattresses. These cork mattresses, in addition to their light weight, furnish very good protection against cold and moisture.

NOTES ON BOOKS.

Bacteriology and Mycology of Foods.—By Fred Wilbur Tanner, M.S., Ph.D. New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. 28*s*. net.

In view of the growing recognition of the importance of the subjects with which it deals, this volume should be assured of a welcome from students of the bacteriology and mycology of foods. It is the outcome of a course of lectures at the University of Illinois, designed to meet the needs of those who wished to fit themselves for food control, food chemists, and for those students in household science who possess a sufficient fundamental knowledge of chemistry—a knowledge which, as the author remarks in the preface, is essential for intelligent work in microbiology.

Dr. Tanner begins by describing bacteriological apparatus, media and their preparation, and staining technique. This is followed by chapters dealing with the classification and description of bacteria, methods of sterilisation and disinfection, proteins and carbohydrates, yeasts and moulds, intestinal bacteria, methods of examining and testing air, water hygiene, and milk and milk products. A particularly interesting chapter, illustrated by a number of excellent coloured plates, is devoted to the bacteriology of eggs. Recent experiences at the breakfast table have led the writer of this note to wish that egg dealers

in this country had a better knowledge of the bacteriology of their wares, and he cordially hopes that they will study Dr. Tanner's description of candling and other devices by which they may be saved from labelling as "new laid" eggs which seem to be upon the point of spontaneous combustion.

The remaining chapters treat of meat and meat products, methods of food preservation, and epidemiology.

The treatment of each section is as full and comprehensive as is compatible with keeping the book within reasonable limits; but for those who desire to study any branch in further detail excellent bibliographies are provided, and these add materially to the usefulness of the volume.

English Eighteenth Century Sculptures in Sir John Soane's Museum. By Arthur T. Bolton, F.S.A., F.R.I.B.A. Soane Museum Publications. 2*s*.

One of the principal aims of Sir John Soane in forming the remarkable museum in Lincoln's Inn Fields was to preserve the actual work of artists of his own time, and his collection contains some fine specimens of painting and sculpture of the last half of the eighteenth century and of the first quarter of the nineteenth. The present pamphlet deals with the sculpture of this period, particularly with the work of Chantrey, Banks, Westmacott, Flaxman, and Wedgwood.

The Soane Museum is of special interest because it is housed in the home of its founder, which is still arranged, so far as possible, as he left it. It is, therefore, singularly free from the "museumy" atmosphere that afflicts one in many public collections, and one has the feeling—especially if one is fortunate enough to be taken over the house by Mr. Bolton—that one is being shown over the collection of a connoisseur by the connoisseur himself. Every corner is full of interest, and one can only be amazed at the amount and the variety of the objects that, without undue crowding, are contained in the house. The Museum is certainly a place that ought to be familiar to every one interested in English architecture, sculpture and painting. There is a fairly common impression that very few people go to it. As a matter of fact, many would be surprised to learn the numbers of its visitors which, we understand, are sometimes such as to throw a severe strain on the accommodation provided.

The "Times" Atlas of the World. Part I. Office of the *Times*, Printing House Square. 2*s*. 6*d*.

Part I. of this welcome atlas contains four maps, Scotland (Southern Section), Farther India, Lower Egypt, and Mexico and Central America. It has been prepared under the direction of Dr. T. G. Bartholomew, who has adopted the orographical colouring familiar to all students of maps, with the result that one gets at a glance an impression of the general surface of the country portrayed. The maps are extremely full—the general index will contain over 200,000 names—but they are equally clear, and they will be valuable alike to the serious student of geography and to the man who is planning a holiday tour.

The *Times* is certainly to be congratulated on its enterprise in bringing out this work. The appearance of the various parts will be eagerly awaited, especially of those showing the territorial redistributions ordained by the Peace Conference.

GENERAL NOTES.

Concrete Sheep Barn.—Although the first cost was double that of the usual type of timber building the use of concrete construction in the case of a large double-deck sheep barn at Denver, U.S.A., had the advantage of securing sanitary conditions, protection from fire, and of reducing maintenance charges to a minimum. The structure in question has two decks (one on ground level, and the other superimposed), and is 422 ft. by 320 ft., the stories being 12½ ft. high. There are no side walls, but a 4-ft. high parapet extends around the upper deck. The building is divided by concrete uprights into a number of panels. These panels are 16 ft. by 16 ft. in plan, except for a 20 ft. width at the central portion to provide for a driveway. Internally, arrangements are made in each of the panels for the attachment of fences and gates to form pens. Even the drinking troughs are of concrete. The flat-slab construction for the upper deck is designed for a load of 150 lb. per square foot. A sawtooth roof covers the central portion of the barn; the outer wings at each end (each comprising four panels) have a flat-slab roof, it having been assumed that sufficient light to illuminate the interior would be admitted through the open sides. Concrete ramps, 15 ft. wide, with grades of 16 per cent. for the sheep runs, and 11 per cent. for the driveways handling supplies, reach to the upper deck. A granolithic finish is given to the floors and ramps in order to resist wear from hoofs.

British School of Archæology at Jerusalem.—The emancipation by Great Britain of the Near East involves exceptional responsibilities in relation to the ancient monuments and antiquities. Palestine and Mesopotamia are not only historical areas of supreme interest about which relatively little is known, but they are filled with sacred associations and abound in sites and monuments, familiar by name to almost everyone from childhood, and revered by the great bulk of civilised humanity irrespective of nationality or religious persuasion. The future administrators are faced, then, with the duty of preserving these historical places and the antiquities that will constantly be coming to light. Moreover, competent bodies will now have full opportunity of exploring systematically these ancient sites, so intimately associated

with the origins of the Jewish and Christian religions. It is evident that whether for preservation or for discovery adequate precaution and preparation are indispensable. Public feeling throughout the world will no longer tolerate any neglect in this respect now that these countries are emancipated, but will rightly demand of the governments and the nations that accept the mandates an adequate provision for the protection of these remains of the past, and for better and fuller information concerning them. Yet, at the present time, Great Britain does not possess the number of trained archæologists of the younger generation necessary for this task; and no institution exists within these areas, such as have long been established at Athens and at Rome, suitably organised to provide such training. With a view to remedying this defect and to providing an adequate organisation on the spot to respond to our obligations and opportunities of the future, the British Academy, at the invitation of, and in conjunction with, the Palestine Exploration Fund, and with the concurrence of the Foreign Office, have appointed a Committee (of which the Chairman is Sir F. Kenyon, F.B.A., and the Director Professor J. Garstang) for the purpose of establishing a permanent British School of Archæology at Jerusalem. While the Palestine Exploration Fund will continue its work as before, the objects of the school will be: (1) To facilitate the researches of scholars; (2) to provide instruction and guidance for students; (3) to train Archæological Excavators and Administrators; (4) the school will assist in every possible way the excavations and explorations of the Palestine Exploration Fund. It may from time to time undertake investigations on its own account, and such operations would be conducted in harmony with the work of the Palestine Exploration Fund. The temporary address for all communications is The Secretary, British School, c/o Palestine Exploration Fund, 2, Hinde Street, Manchester Square, London, W. 1.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

February 4.—Alfred E. Hayes, General Secretary, English Language Union, "The English Language and International Trade." Sir Edward W. Brabrook, C.B., will preside.

February 11.—Lieut.-Commander Norman Wilkinson, R.N.V.R., O.B.E., R.O.I., R.I., "Naval Camouflage."

February 18.—Sidney Preston, C.I.E., "English Canals and Inland Waterways." Neville Chamberlain, M.P., will preside.

February 25.—James Currie, C.M.G., Ministry of Labour (Training Department), late Principal, Gordon Memorial College, Khartoum, "Industrial Training."

March 3.—William James Garnett, First Secretary, H.B.M. Diplomatic Service, "Mongolia from the Commercial Point of View."

March 10.—H. M. Thornton, "Gas in relation to Industry and Housing."

March 17.—William Worby Beaumont, M.Inst.C.E., "Street Passenger Transport of London."

March 24.—Air-Commodore Edward Maitland, C.M.G., D.S.O., "The Commercial Future of Airships."

April 14.—Joseph Thorp, "The Fundamental Basis of Good Printing."

Colonial Section.

Tuesday afternoons, at 4.30 p.m.:—

February 3.—Sir Francis Watts, K.C.M.G., D.Sc., Imperial Commissioner of Agriculture for the West Indies, "Tropical Departments of Agriculture, with special reference to the West Indies." Lieut.-Colonel Sir David Prain, C.M.G., C.I.E., LL.D., F.R.S., Director of the Royal Botanic Gardens, Kew, will preside.

March 2.—G. F. Scott Elliot, M.A., B.Sc., F.R.G.S., "Trade Routes for the Empire in Africa." Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., will preside.

May 4.—Professor William A. Bone, D.Sc., Ph.D., F.R.S., "Lignite."

Dates to be hereafter announced:—

Charles H. Sherrill, "Stained Glass."

Lady Inglefield, President, Buckinghamshire Lace Association (North Bucks and Bedfordshire), "The Hand-made Lace Industry."

Graily Hewitt, "Rolls of Honour."

Charles Crowther, "The Arts and Crafts of Japan" (with examples from the author's private collection).

William Cramp, D.Sc., M.I.E.E., "Pneumatic Convoying Plants, with special reference to the Transport of Grain."

L. Gaster, "Industrial Lighting in its relation to Efficiency."

Sir Valentine Chirol, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

Brigadier-General Lord Montagu of Beaulieu, C.S.I., "Roads and Transport in India."

Sir George Cunningham Buchanan, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

CANTOR LECTURES.

Monday evenings, at 8 p.m.:—

CAPTAIN H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S., Fellow of Downing College, Cambridge, and formerly of the Royal Air Force, "Aircraft Photography in War and Peace." Three Lectures.

Syllabus.

LECTURE III. – FEBRUARY 2.—The use of aerial photography in exploration and survey in times of peace—Comparison of a photograph with a map—How maps may be compiled or improved—Application to exploration—Things concealed and revealed—Surveys for special purposes—Limitations and future of the method.

CHARLES FREDERICK CROSS, B.Sc., F.R.S., F.C.S., "Recent Research in Cellulose Industry." Three Lectures.

February 16, 23, March 1.

WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.

May 3, 10, 17.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 2...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Captain H. H. Thomas, "Aircraft Photography in War and Peace." (Lecture III.)

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Sir Andrew Wingate, "India."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

British Academy, King's College, Strand, W.C., 5 p.m. Ven. Archdeacon Charles, "The Apocalypse." (Lecture I.)

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. Messrs. H. M. Wells and J. E. Southcombe, "The Theory and Practice of Lubrication: The Germ Process."

Geographical Society, Central Hall, Westminster, S.W., 8.30 p.m. Major-General Sir Frederick Sykes, "Air Routes of the Empire."

Actuaries, Institute of, Staple Inn Hall, Holborn, W.C., 5 p.m. 1. Mr. A. Henry, "Some further suggestions on the subject of Approximate Valuations." 2. Mr. H. L. Trachtenberg, "A New Method of Valuing Policies in Groups."

Farmers' Club, at the Surveyors' Institution, 12, Great George-street, S.W., 4 p.m. Mr. Martin H. F. Sutton, "The Future of the Potato Crop, with special reference to Wart Disease and Immune Varieties."

TUESDAY, FEBRUARY 3...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Sir Francis Watts, "Tropical Departments of Agriculture, with special reference to the West Indies."

Royal Institution, Albemarle-street, W., 3 p.m. Professor G. Elliot Smith, "The Evolution of Man and the Early History of Civilisation. Lecture II.—Elephants and Ethnologists."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. L. A. Jones, "A Non-Intermittent Sensitometer."

WEDNESDAY, FEBRUARY 4...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. A. E. Hayes, "The English Language and International Trade."

Aëronautical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Squadron-Leader J. E. M. Pritchard, "Rigid Airships and their Development."

Geological Society, Burlington House, W., 8 p.m.

Automobile Engineers, Institution of, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. Messrs. A. P. Young and H. Warren, "The Process of Ignition."

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Annual General Meeting. 2. Messrs. F. S. Sinnatt and L. Slater, "An Investigation into the Composition of the Unsaturated Hydrocarbons present in Coal Gas." 3. Mr. H. Trickett, "The Estimation of the Available Oxygen in Sodium Perborate and in Perborate Soap Powders."

Industrial League and Council, Central Hall, Westminster, 7.30 p.m. Major E. A. Pells, "Conditions the Workers may Control."

Royal Archaeological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. F. E. Howard, "Some Mid-Suffolk Churches and their Woodwork."

THURSDAY, FEBRUARY 5...Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. Dr. R. R. Gates, "On the Existence of Two Fundamentally Different Types of Characters in Organisms."

Chemical Society, Burlington House, W., 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. E. Conrady, "Recent Progress in Applied Optics." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Engineer-Commander E. J. Mowlam, "Naval Pictures."

Dyers and Colourists, Society of (West Riding Section), Leeds. Dr. J. B. Oesch, "Development of the Chemical Industry in Switzerland during the War."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 6 p.m. Mr. H. K. G. Bamber, "Demonstration on the Practical Testing of Cement."

FRIDAY, FEBRUARY 6...Technical Inspectors' Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.30 p.m. Mr. J. Waite, "The Treatment of Steel."

Royal Institution, Albemarle-street, W., 9 p.m. Professor Sir Walter Raleigh, "Landor and the Classic Manner."

University of London, University College, Gower-street, W.C., 5 p.m. Dr. T. Borenius, "Mediæval Art." (Lecture IV.)

SATURDAY, FEBRUARY 7...Royal Institution, Albemarle-street, W., 3 p.m. Sir Frank W. Dyson, "The Astronomical Evidence Bearing on Einstein's Theory of Gravitation." (Lecture II.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

WEDNESDAY, FEBRUARY 11th, at 4.30 p.m. (Ordinary Meeting.) LIEUT.-COMMANDER NORMAN WILKINSON, R.N.V.R., O.B.E., R.O.I., R.I., "Naval Camouflage." REAR-ADMIRAL SIR DOUGLAS EGREMONT R. BROWNRIGG, Bt., C.B., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CONFERENCE ON HOUSE FURNISHINGS.

The Council have arranged to hold a Conference of Manufacturers and Distributors of House Furnishings and of others specially interested in the subject, in connection with the Ideal Home Exhibition at Olympia on Thursday, February 19th, at 3 p.m.

The chair will be taken by the Right Hon. Sir Auckland Geddes, K.C.B., M.P., President of the Board of Trade; Sir Henry Trueman Wood, Chairman of the Council of the Royal Society of Arts, and Sir Frank Baines, C.B.E., M.V.O., Principal Architect of H.M. Office of Works, will also speak, and thereafter the meeting will be invited to take part in a general discussion.

The main object of the conference is to initiate a scheme whereby the manufacturers and distributors in the different industries concerned may have an opportunity for interchanging views with regard to the development of their trades as to both quality and quantity of production. The Society has already convened conferences of manufacturers and distributors in other industries, as an outcome of which standing committees have been formed which will meet from time to time to discuss questions affecting the interests of the trades concerned. It is believed that these will serve a very useful purpose, and in a similar way it is hoped, after the general conference at Olympia, to hold special conferences of manufacturers and distributors of the various articles used in house furnishing.

Fellows of the Society desiring to attend the conference are requested to communicate with the Secretary, who will be glad to forward to them cards of admission to the Exhibition.

CANTOR LECTURE.

On Monday evening, February 2nd, CAPTAIN H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S., Fellow of Downing College, Cambridge, delivered the third and final lecture of his course on "Aircraft Photography in War and Peace."

On the motion of the Chairman, LIEUT.-COLONEL ALLAN J. CUNNINGHAM, a cordial vote of thanks was accorded to Captain Hamshaw Thomas for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

Tuesday afternoon, February 3rd, 1920; LIEUT.-COLONEL SIR DAVID PRAIN, C.M.G., C.I.E., LL.D., F.R.S., Director of the Royal Botanic Gardens, Kew, in the chair. A paper by SIR FRANCIS WATTS, K.C.M.G., D.Sc., Imperial Commissioner of Agriculture for the West Indies, on "Tropical Departments of Agriculture, with special reference to the West Indies," was read by CAPTAIN ARTHUR W. HILL, Sc.D., M.A., F.L.S.

The paper and discussion will be published in a subsequent number of the *Journal*.

EIGHTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 4th, 1920; SIR EDWARD BRABROOK, C.B., F.S.A., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Brougham, William Henry Charles, Wallington, Surrey.
Darby-Legge, Captain A. W., R.A.S.C., London.
Doyle, Trevor Mervyn, Sydney, New South Wales.

Early, James Vanner, Witney, Oxon.
Garforth, Sir William E., LL.D., M.Inst.C.E., Pontefract.
Gibson, Alfred Herbert, F.S.S., Harrogate.
Guthrie, Thomas Maule, J.P., Brechin.
Holmes, William, London.
Hoxie, William D., New York City, U.S.A.
Hughman, Ernest Montague, Calcutta, India.
Lovekin, Luther D., Philadelphia, Pa., U.S.A.
Macara, Sir Charles Wright, Bt., Manchester.
Nasmith, Frank, Manchester.
Nicoll, Allardyce, M.A., Horton-cum-Studley, Oxon.
Powell, A. Cecil, Weston-super-Mare.
Shafik Pasha, H. E. Mohamed, Minister of Agriculture, Cairo, Egypt.
Stanners, Robert Whitfield, B.Sc., M.A., Cambridge.
Unwin, Mrs. Jane Cobden, London.
West, Edgar Louis, B.A., Rocester, Staffordshire.
Willson, P. G., London.
Wright, Commander Nathaniel H., U.S. Navy, Washington, D.C., U.S.A.

The following candidates were balloted for and duly elected Fellows of the Society :—

Adams, Sidney James, London.
Arthur, Major Edmond John, Birmingham.
Ashworth, Arthur, Bury.
Calvert, Alderman Joseph, J.P., Middlesbrough.
Clifford, William John, Brockenhurst, Hants.
Colwyn, Right Hon. Lord, Colwyn Bay.
Croft, Cyril Murton, London.
De Cruez, Jos. Alex., London.
Dickinson, Mrs. M., Brighton.
Evans, Joseph S., Commander, U.S. Navy, Washington, D.C., U.S.A.
Froud, Edgar Arnold, London.
Ghatalah, M. H. P., Banganapalle, India.
Goslin, James, Johannesburg, S. Africa.
Greenshields, J. N., K.C., Montreal, Canada.
Griggs, Arthur Robert, Bromley, Kent.
Hart, George Eaton, London.
Hendry, Brigadier-General Patrick W., C.B., Glasgow.
Kelsey, William K., B.A., London.
Knowlton, Elliot Ainsworth, Rochester, U.S.A.
Lawrence, John Edward, London.
Longden, Major Alfred Appleby, D.S.O., London.
Mermoz, Francisco Alberto, Buenos Aires.
Mitchell, John, London.
Mitchell, John M., M.I.Mar.E., Sydney, N.S.W., Australia.
Morrell, Clayton Conyers, London.
Morris, Arthur Percy, B.Sc., Assoc.M.Inst.C.E., Burma.
New Jersey, The Right Rev. Bishop of, Princeton, New Jersey, U.S.A.
Palmer, Austin Norman, New York City, U.S.A.
Penicud, John William, Paris.
Pettigrew, J. Stewart, Glasgow.
Redgate, C., Heanor, Derbyshire.
Rhodes, John Edwin, M.D., Chicago, Illinois, U.S.A.
Sayner, George Smith, Richmond, Surrey.
Shay, Peter Yevent, B.Sc., Sheffield.
Silverman, Professor Alexander, Pittsburgh, Pa., U.S.A.
Spear, William, Edgware, Middlesex.
Stanfield, George John, Carlisle.
Sutherland, Charles H., Nova Scotia, Canada.
Taft, William Howard, LL.D., D.C.L. (Ex-President of the United States), New Haven, Conn., U.S.A.
Tattersall, John, Enschede, Holland.
Thomson, George Clark, Saskatchewan, Canada.
Vaus, Frank H., London.
Walsh, Lawrence J., Southbridge, Mass., U.S.A.
Willis, James Harold, B.Sc., Cardiff.
Woodhouse, William H., Crewe.
Wright, Lieut.-Colonel Clifton Vincent Reynolds, London.

A paper on "The English Language and International Trade" was read by Mr. Alfred E. Hayes, General Secretary English Language Union.

The paper and discussion will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

SEVENTH ORDINARY MEETING.

Wednesday, January 28th, 1920; Monsieur Emile Cammaerts in the chair.

The Chairman, in introducing Sir Cecil Hertslet, the author of the paper, said he thought his first duty, as one of the representatives of the Anglo-Belgian Union, was to thank the Royal Society of Arts for having afforded their hospitality to the Union and for having organised the present meeting. He wished to take the opportunity to say a few words, not about the general work of the Anglo-Belgian Union, which was carried on with so much activity and devotion by its honorary secretary, Mr. Maudslay, but about a small part of that work, *i.e.* the work of the Educational Committee, which was organising lectures all over the country in order to promote interest in this country in Belgian affairs. He felt sure those present would agree with him that it would be a good thing that the interest in Belgium, which was shown so generously by this country during the war, should not completely die away, but that at least some part of the great flame of enthusiasm that was then kindled should be kept alive. It was for that purpose that the lectures were organised, and, considering the difficulties that had to be overcome, they had met up to the present with considerable success. In the previous winter seventy-five lectures had been delivered, and it was hoped that one hundred would be organised during the present winter. They covered a very wide range and dealt with every possible subject connected with Belgium, such as Belgian history, Belgian art, the position of Belgium during

the war, and social questions, and the audiences to which they were delivered varied from secondary schools to universities, and from workmen's clubs to scientific and literary societies. He was glad to say that the work of the Union was not one-sided. There was not only the work carried out by the British section of the Union in this country; there was also the work carried out in Belgium by the Belgian section. It was not only important that the interest taken by this country in Belgian affairs should not die away, but it was also very important that the interest in British affairs and the appreciation of the work England had done for Belgium should not die away in Belgium itself; that was why the work was really two-sided. In Belgium the work had been delayed, as could well be imagined, by the difficulties of reconstruction, but it had now been very well begun. Several lectures had already been given in Belgium by Belgians conversant with British affairs, and Captain Spicer Simpson, of the British Navy, had just been invited to go for a tour in Belgium to deliver lectures on the efforts of the British Navy during the war, a subject the importance of which was not yet perhaps quite realised in Belgium by every section of the population. Owing to the very limited means available, such work could not be carried out without the support of certain enthusiasts, and among those enthusiasts there was no one who had shown so much vigour, efficiency and activity as Sir Cecil Hertslet, who had already delivered sixty lectures for the Union, entailing extensive tours in France, in the occupied parts of Germany, to which he had been invited by G.H.Q., and in military camps in Ireland. The Union was very grateful to Sir Cecil for the work he had done; he had never been called upon without answering very readily to the appeal. It was all the more gratifying to the Belgians that Sir Cecil was not only a very good friend to them but a very old friend. His knowledge of Belgium dated from long before the war; he had lived in Antwerp as British Consul-General for fifteen years, so that he knew something of the Belgians —he knew their good qualities and he knew their faults. The attitude that Belgium took up in 1914 probably did not surprise Sir Cecil in the least, nor was he surprised probably that some of the Belgian refugees in this country were found divested of the shining armour of Sir Galahad! It was a case where the old friendship proved the true friendship, based upon knowledge, and it was a very precious one because it was not apt to be quickly discouraged. He felt very unfit to take the chair at the present meeting, but he did not wish to miss the opportunity of thanking Sir Cecil Hertslet for all he had done for Belgium. The idea of a Belgian introducing a British lecturer to a British audience struck him as rather original, and he thought it was a crowning proof of Anglo-Belgian friendship. He looked forward to the time when he or any other Belgian speaking in Brussels to a Belgian audience would be introduced by a British resident in Belgium.

The paper read was—

THE RUIN AND RESTORATION OF BELGIUM.

By Sir Cecil Hertslet,

Late H.B.M. Consul-General for Belgium.

It is a matter of very great difficulty for Britons, who live in a country almost untouched by the horrors of war, to realise, even imperfectly, the immensity of the tragedy that has overwhelmed little Belgium—a country placed under the solemn guarantee of the Great Powers, and which, relying on the binding force of that guarantee, honourably fulfilled all its obligations towards Europe, and welcomed within its borders, as honoured guests, the citizens of every country. No charge has been levied against Belgium that she ever deviated by a hair's breadth from her neutrality. Politically, Belgium has been faithfully neutral; socially, she has offered hospitality to all.

At the end of July, 1914, Belgium had attained to a prosperity never before known since the country received from the guaranteeing Powers the gift of national independence. In eighty-four years the population had nearly doubled, and Belgium had become the first country in Europe from no less than four separate points of view: (1) Density of its population—397 per square mile; (2) the yield per acre of its crops; (3) the relative development of its railway system compared with its superficial area; (4) the proportional value of its trade activities compared with its population.

In spite of its narrow territorial limits, Belgium had acquired the fifth rank among the most important trading nations of the world. No wonder that such a great result inspired the cupidity of Belgium's powerful neighbour.

The great city and port of Antwerp, the commercial and maritime metropolis of the country, was at the height of its prosperity, as the number of ships entering the port during the previous year was greater than it had ever been before. The vast river-quay space and dock accommodation was insufficient; many ships wishing to ascend the River Scheldt and enter the harbour were unable to do so, and had to remain at Flushing, at the mouth of the river, until other ships came down the river and made room for them at the quays and docks; and the municipal authorities were occupied in feverishly excavating new docks in order that they might be able to cope with the ever-increasing volume of traffic. This was the position in 1914 at Antwerp, one of the first ports in the world.

The industrial and commercial activities of the country were unceasing. At Liége firearms of all descriptions were being manufactured, iron and steel works were in full operation; miners were hard at work both in the district of Liége and in the neighbourhood of Charleroi. Metallurgical works, including blast furnaces, were busy at Charleroi, where the manufacture of plate and of all kinds of glass was also one of the principal industries. Indeed, almost the whole country was a beehive of industry, and factories innumerable were at work in the districts of Brussels, Antwerp, Charleroi, Mons, and Ghent. Ghent was the cotton capital—the Manchester of Belgium. Here there were more than forty mills, having in all nearly a million and a half spindles.

Although the dark cloud of war was ever overshadowing them, the Belgians were unwilling to believe—and, indeed, until the German ultimatum was sent to them, they were unable to grasp the fact—that to two of the guaranteeing Powers—Germany and Austria-Hungary—their solemn word of honour, given in the name of the Most Holy and Indivisible Trinity, was nothing more valuable than a "scrap of paper."

It is not my intention to dwell upon the massacres, pillages, and outrages of all kinds that disgraced the German army in Belgium during the reign of terror of August and September, 1914. Full details of the atrocities committed by the German troops are given, with irrefutable evidence, in the Report of the British Commission of Inquiry presided over by Viscount Bryce. I am speaking to-day on the ruin of Belgium and the restoration to come, but no picture of the ruin of Belgium would be complete without a brief reference to the appalling events which occurred in the early days of the war, when German Kultur held unrestrained domination over the unfortunate people whose independence and neutrality the King of Prussia had given his solemn word to protect.

The city of Antwerp fell on October 9th, 1914, and with its fall the reign of terror in Belgium came to an end, so far as burnings of churches, destruction of villages, and outrages and massacres were concerned. Telegraphic and postal communication with Antwerp was cut off on the day that I left the city, October 7th, 1914. A few days later the Germans occupied Ostend and the Belgian coast, with the exception of a little strip near Furnes, close to the French frontier. The King and Queen of the Belgians, and the Belgian army, withdrew to a small district behind the lines in the south-western corner of the country, with Ypres as its centre and the Germans—barbarous in their Kultur and merciless in their attitude towards the Belgians—took possession of the whole of the rest of the country, where they exercised so-called civil government.

In October, 1914, Belgium was completely cut off from the outside world, and the country was plunged into dense and impenetrable obscurity for more than four years. News occasionally filtered through by way of Holland, but until the liberation of Belgium no one in England could communicate with Belgium, nor could the Belgians correspond with us.

The method by which the ruin of Belgium was accomplished was not the violence of the savage, pillaging and murdering without control, in a wild orgy of death and destruction, as in the early days of the war, but a cold, calculated scheme of organised theft.

The Germans requisitioned, they sequestrated, or, on the slightest pretext, they simply stole anything and everything they wanted. A German official document, setting forth instructions for the pillage of Belgium, has recently come to light. I will read an extract from it:—

> The great length of the war makes it necessary to collect all available raw materials. The interests of the population of an occupied territory, and even those of neutrals, cannot be put in the balance with those of the German Empire. All hidden stores must be collected, and invaded districts must be exploited to the extreme limit, in the interests of German industry.

A list is then given of the articles which are particularly recommended for seizure: automobiles, oils, seeds, textiles, papers, motors, machines, tools of all sorts, chemical products. And then come directions as to how these are to be obtained.

> Confiscation is the most economical means of procuring what is wanted, as the owners will then receive neither indemnity nor receipt. As much as possible should be confiscated.

This is but another proof that the devastation of Belgium was officially organised. I will repeat the words of a Prussian member of Parliament:—

> All who know the present state of Belgian industry will agree with me that it will take several years before Belgium will be able to think of entering into competition with us Germans in the world market.

Or, again, the German officer superintending the carrying off of the machines from the

Providence Iron Works and Foundries, near Charleroi, remarked :—

It is regrettable, but I am acting under orders from Berlin. Belgium's economic position must be destroyed, and she must be reduced to such a position that she will be unable to produce anything.

Nothing remains of the Providence Works except the walls and the power station. At the foundry the cranes and machinery have been broken up. Even the iron flooring has been removed. The rolling-mills have been dismantled and carried off, the foundations have been blown up with dynamite, the large blast pipes connecting the new and the old works, and the sheds, where stocks of ore and coal were stored, have all disappeared.

This is the state of the Providence Works, one of the most important of its kind in Belgium.

I have been speaking about a single factory, but the same thing occurred in other parts of Belgium. I have a list of the most important factories which have been completely destroyed, and another of those which were partially wrecked. But the Germans did not confine themselves to robbing the country of material only. For example, at the great Cockerill Works, plans, drawings, archives, and the secrets of manufacture were all stolen.

The theft of the machinery from the factories all over Belgium necessarily paralysed all Belgian industries. The machinery had been taken to Germany for the express purpose of enriching that country at the expense of her little neighbour. Selfish persecution for the sake of ruining a rival has never been so disgraceful as this, and it is satisfactory to know that Germany has already been compelled to restore 40,000 tons of material valued at £2,000,000, and that out of 9,797 machines taken away 5,069 have been recovered. The work of the Belgian Commission of recuperation was greatly helped by a complete card index, showing the property stolen and its destination, which, in their hurried retirement in November, 1918, the Germans neglected to take away with them.

The central committee of the heads of the several Belgian industries estimates the loss incurred by those industries at nearly £400,000,000, those most affected being the metal industry and the textiles, which were not only the most important and best equipped but at the same time the ones that were in direct competition with Germany.

Belgium has received from the Allies a right of priority on the indemnity to be recovered from Germany of £100,000,000. It is interesting to compare this figure with Belgium's actual losses on her industries alone.

The Belgian Government has now completed its inquiry on the state of the various industries during the German occupation. With the exception of the coal mines, which were kept going by order of the Germans, and for their benefit since they took 85 per cent. of the production, the ruin of Belgian industry is sufficiently illustrated by the following facts: In 1913, 125 coal mines were active; in 1917, 116. In 1913 coke was made at forty-one works; in 1917, at fourteen. In 1913 the metal industry of Belgium possessed fifty-four blast furnaces; in 1917 only one of those was active. In 1913 there were twenty-nine steel works and twenty-four zinc works. These numbers were reduced in 1917 to four steel works and six zinc works respectively.

What really happened was this. The Germans at first endeavoured to keep the Belgian industries going for their own benefit, and it was only when these attempts failed that they commenced their scheme of systematic destruction.

In the last few months of 1914 and in 1915 the German Governor of Belgium seized every opportunity of reassuring the Belgians, and of endeavouring to convince them of the benevolent intentions of Germany. He pretended that the Empire had one desire only—the restoration of the commercial and industrial life and prosperity of the country, which had been troubled by the events of 1914. He appealed to the goodwill of all Belgians; he urged them to set to work at once at their particular trade or industry in the interest of the country. He faithfully promised them that he would ask of them nothing incompatible with their patriotism. The Belgians were not deceived by this appeal, and when it failed manufacturers were required to work for the German army. If they refused to serve the interests of Germany, their factories were sequestrated, and controlled either by German functionaries, or directly by the army.

In 1917 a decree was issued prohibiting the employment in any factory of more than twelve workmen or the use of a motive power greater than that of five horses. This measure placed at once all the industries in Belgium under German control. Many establishments closed their doors, and thousands of labourers were thrown into the streets.

This led to forced labour and the deportation of Belgians. It is obvious that if the whole

of the able-bodied population was compelled to work for the enemy, or suffered—as an alternative—deportation, the industrial life of the country must cease, and that by this means Germany, if unable to lay hands on the Belgian industries, would be able to exploit Belgian labour.

Two protests against the deportations were made in 1916, one by Cardinal Mercier, the other by Belgian workmen. Cardinal Mercier's protest was made in the name of the Belgian Episcopate, and, like the workmen's appeal, was a lengthy document. I will give a few of its salient features. It was called "The Cry of Alarm of the Belgian Bishops to Public Opinion," and stated that every day the German military authorities deported from Belgium to Germany thousands of inoffensive citizens who had to submit to forced labour. On October 16th, 1916, the Cardinal made a formal protest to the German Governor of Belgium, and sent a copy of his protest to the representatives at Brussels of the Pope, Spain, the United States, and Holland. When the protest was made it was no longer a question of forced labour in Belgium, but in Germany, for the profit of the Germans. The Germans made many excuses for the deportations, but the plain truth, declared the Cardinal, was that every deported workman was one soldier more for the German army. He took the place of a German workman who was at once enlisted.

Cardinal Mercier stated that the Germans enrolled the unemployed, assuredly, but they recruited also, in great numbers, amounting in the Mons district alone to more than a quarter of the whole, men who had never ceased to work and who belonged to the most diversified trades and professions—butchers, bakers, master-tailors, workmen in breweries, electricians, gardeners; they even went so far as to take all the young people, students at the colleges, at the universities, and at the more advanced schools. And yet two high authorities of the German Empire had formally guaranteed to him the liberty of his fellow-countrymen. Cardinal Mercier concluded his impassioned Cry of Alarm in these words: "May Divine Providence inspire whoever may possess an authority, a word, a pen, to rally round the humble Belgian flag for the abolition of European slavery!"

On November 19th, 1916, the workmen of Belgium, whose delegates met in secret, issued an appeal to the workmen of the world, which was issued in the name of them all, without distinction of party or religion. This document gave an account of the martyrdom of Belgium. It stated that the country had been made a prison, that its frontiers had been armed against the Belgians, as if those frontiers were a battle front, by entrenchments, by barbed and electrified wire, and guarded by sentinels, and that all their constitutional liberties had been abolished. It went on to say that Germany had mulcted its victims in an immense war contribution which had already exceeded £40,000,000, and which increased at the rate of £1,600,000 a month; that Germany had taken away, under the form of pillage, confiscation, requisitions, and forced sales, more than £200,000,000 worth of provisions and goods of all descriptions, as well as industrial and agricultural products. At the same time she had removed to Germany the greater part of the material of the factories, the machines and their accessories, and had thus caused a stoppage of all industries and had brought about a want of employment, which was almost universal among the working population.

The Belgian workmen brushed on one side the German argument that the want of employment was attributable to the Allied blockade. On the contrary, they distinctly stated that the Germans themselves created this want of employment in order that they might turn it to their own profit; and they laid stress on the fact that Great Britain had consented to permit the Belgians to import raw materials, but that the Germans refused to allow diplomatic control by a neutral Power, which was an indispensable condition to prevent those raw materials from being taken by Germany. Moreover, Belgian towns, industrial associations, and men of standing in the country, were forbidden under severe penalties, to give work to the unemployed, to allow their professional education to be carried on, or to employ them on works of public utility. By these devices in November, 1916, about 500,000 Belgian workmen had been reduced to idleness, and to these 500,000 involuntary idlers, created by Germany and kept in idleness by that country, the German taskmasters gave the dread alternative of either working for Germany or of being reduced to a state of slavery. The fate of these Belgian workmen was either exile and deportation, or forced labour, to the profit of the enemy and against their own country. No crueller fate had ever been reserved for criminals by tyrants in days gone by. And what, indeed, was the crime committed by these men? Involuntary idleness, which the tyrant himself had created and

maintained. For this, Belgian workmen were arrested by thousands every day; they were torn away from their wives and children; surrounded by bayonets they were dragged to cattle trucks and carried off either to Germany or to the German trenches in France. In Germany they were cast into the mines, stone quarries, or limekilns, whatever might be their age, their trade, or profession. Young people of seventeen years of age were deported, as well as men of sixty years and upwards.

The Belgian workmen concluded in these simple, dignified, and patriotic words: "Whatever tortures we have to suffer, we only wish for peace when our country is independent and justice has triumphed."

And yet, with the whole story of the deportations known to the civilised world, and with countless other indications against it, the German Government, in its reply to President Wilson of October 21st, 1918, had the effrontery to "protest against the reproach of illegal and inhumane actions made against the German land and sea forces and thereby against the German people."

I have spoken in some detail of the deportations, as the Germans brought about the ruin of Belgium quite as much by deporting the labourers as by the fines, requisitions, and the removal of machinery from the factories.

The most crying wrongs of the Belgian people may be summarised as follows (I have taken the figures from the report of the commission of inquiry instituted by the Belgian Government):—

More than 6,400 inoffensive civilians, among whom were priests, men more than 80 years old, nearly 600 women and 500 children, some of whom were only a few months old, were massacred by rifle fire, bayonet thrust, or even by machine guns, on the pretext that they had fired upon the Germans. 150,000 persons were deported to the enemy front or to Germany, of whom more than 5,200 died. 20,000 houses, many churches, and the University of Louvain, with its celebrated library, were destroyed by fire, which no necessity of war could possibly justify.

I have already mentioned that the loss to the Belgian industries is estimated at £400,000,000. In addition, every year Germany set apart £3,200,000 from the Belgian budget to be devoted to purely German purposes. Apart from the special contributions levied on the cities, Germany exacted a war tax of £1,600,000 every month from the whole country, which was raised progressively to £2,000,000 and £2,400,000.

With regard to requisitions, it will be sufficient to mention that the country was gradually emptied of all raw materials, and that even in private houses every article in copper and brass, and all the wool, were seized.

The distribution of all foodstuffs was controlled and centralised by the German administration in the interest of Germany. If the Belgians had had to live on the scanty supply which still remained over after German wants had been supplied, and had not been helped by the inter-allied Commission for relief in Belgium, a famine in the country could not have been avoided.

Belgium was robbed of 34 per cent. of its cattle, including 322,850 cows, but the Treaty of Peace only provided for the restitution to Belgium of 50,000 cows and 40,000 heifers. One would have thought that this small proportion of the stolen property would have been restored to Belgium by Germany without demur, but difficulties have been raised, and it has been suggested that Germany should be allowed to retain all the milch cows which are now in that country, in complete disregard of the fact that even if there is a scarcity of milk in Germany, the Belgians suffered unjustly in this respect all through the German occupation, and that at present there is a shortage of milk in Belgium, especially in Flanders.

Now that we have witnessed the ordeal that Belgium experienced, and the tremendous losses inflicted upon her, we may be able to understand the difficulties experienced since the Armistice and the amount of energy which has been put into the work of reconstruction. When I went back to Antwerp a few days after the Germans had left the town, I found a dead city and an empty harbour. Railways, bridges, and roads had been destroyed by the retreating enemy over more than half of the country. Canals were blocked with masonry and sunken barges. Almost every industry was at a standstill, and wherever the works had not been destroyed or machinery removed, lack of raw material and fuel prevented any activity. Workmen without employment wandered aimlessly about in small groups, and the children especially showed evident signs of underfeeding and misery. Three and a half million persons were still more or less dependent on relief, nearly a million were completely out of work. Even the fields, which I was accustomed to see so well cared for before the war, showed

evident signs of neglect. There were scarcely any draught animals, and a few lean cows grazing in the pastures were only a shadow of the numerous and well-nourished herds to which Flanders owed its reputation as a cattle-grazing country. To cope with such a desperate situation the Government lacked, for a long time, the necessary credits, since it was only in May last that Belgium was assured by the Allies of definite financial compensation, including the remission of her war debts due to them.

In spite of these unavoidable delays, the high cost of living and the almost insuperable difficulties of securing raw materials during the first months, the situation improved rapidly. It is not in the Belgian temperament to hanker after the impossible, or to spend its energy in vain regrets. I have had several opportunities of visiting Belgium since the spring of last year, and each visit marked a new stage of progress. Some discontent was shown in regard to the high cost of living, the low exchange of the franc, and the failure at the time to obtain satisfaction in the revision of the 1839 treaties with regard to the military security of the country, but everyone seemed eager to work and to make full use of the opportunities afforded by the financial settlement. The railway communications were practically restored, and the traffic in passengers and merchandise reached from 60 to 70 per cent. of pre-war standard. Owing to numerous public works undertaken in every part of the country, and to the re-starting of certain industries, the number of unemployed was reduced to 200,000, and the relief work had almost ceased to exist. I could no longer see any sign of the despondent idleness of the days immediately following the Armistice; streets were crowded with people, but their movements were no longer purposeless, the business activity of pre-war days was already restored. Production in the mining districts which were the least affected by the occupation had reached 85 per cent. of the pre-war output, part of this coal being exported. Round Ghent the spinning-mills were practically all working, and the town was again surrounded with its girdle of smoking factories. The number of spindles of cotton produced in November last was 1,200,000 against an average of 1,700,000 in pre-war days. Similar progress has been made all over the country by the sugar factories, which, depending mostly on the beetroot crops, were some of the first to be restarted, the production being already considerable enough to allow export. Though the production of glass-works is only a little over 30 per cent. of pre-war standard (1,500,000 square metres per month against 3,750,000 in pre-war days) glass is already one of the main articles of export. As soon as exports can be increased the value of the franc is bound to improve, and in the policy of increasing production as much as possible, in order that exports may be increased, the Government is greatly helped by employers and workmen alike.

There have been some labour troubles in Belgium lately, as in every other industrial country, but most of them have been arranged amicably. Within the last year 145 disputes have been settled by arbitration, notwithstanding the considerable progress made by the trade unions, as well as by the Socialist party, which is strongly represented in the present Government. This conciliatory spirit may be largely attributed to the patriotism of the masses stirred by common sufferings under German occupation, and to the fact that instead of being wearied by over-production and extra hours during the war, most of the Belgian workmen were only too eager to resume work after long years of forced idleness.

In regard to shipping at Antwerp the position has wonderfully improved since the Armistice. Owing to the closing of the Scheldt during the war, all navigation ceased. The system of railway lines serving the docks and river-quays had become overgrown with grass and weeds. The river was silent and deserted. Now all is changed. 2,404 ships, with a tonnage of 2,603,584 tons, entered the port during the first seven months of 1919. This represents nearly a third of the shipping that entered Antwerp during the first seven months of 1914, and the progress is still going on from month to month.

At the same time, it must be admitted that the adverse trade balance is still serious, the annual excess of imports over exports having risen from £40,000,000 in pre-war days to £112,000,000 in 1919. Many months must elapse before the metal industry in particular, which suffered the most severely of all, will attain to its former prosperity.

The housing problem is a difficulty in Belgium, as it is in this country. The country has lost 150,000 dwellings through the war and the paralysis of the building trade during the German occupation, while in the devastated area only 4,000 houses have up to the present time been erected. This question and the general one of the restoration of the Yser district is now engaging the earnest consideration of the

Belgian Government, and there is every hope that great progress will be made in the course of the present year.

I have alluded to the progress made by Belgium from 1830, the year of her independence, until 1914, when the country was crushed by the war. We are now witnessing a similar revival, but this should not make us forget the tragedy of the German invasion and occupation.

The years fly quickly by, and the early days of the war have already passed into history, but the world, and in particular the British Empire and France, should never forget what Belgium did in those fateful days more than five years ago. The immensity of Belgium's overwhelming sacrifices will, however, be fully realised by the generations to come. We ourselves are living in the midst of events that have shaken the world to its foundations, and it is almost impossible for us to view the great struggle between liberty and tyranny in its proper perspective. That is why it is so difficult for us to appreciate at its true value the greatness of Belgium's decision at the beginning of August, 1914. Still, it is well for us to remember what would most certainly have happened if Belgium had decided to submit to the German ultimatum, and to allow the German army a right of way over Belgian soil. If the King of the Belgians had allowed the German army an unopposed passage across Belgian territory, if neither Liége nor Antwerp had offered resistance to the invader, then Dunkirk, Calais and Boulogne would have fallen into the power of the Germans before it had been possible for us to throw a single division into France. There would have been no resistance of the British Army at Mons, no Battle of the Marne, and the fate of Paris would have been sealed.

Honour and gratitude compel us, therefore, as a nation, to do everything in our power to restore Belgium to her former prosperity. Our own interests, too, demand this, as you cannot fail to realise, if you reflect on what our position would be if, through a lack of sympathy on our part, Belgium should fall in the future under the commercial domination of Germany. I trust, therefore, that on grounds of gratitude, patriotism, and in the interests of the British Empire, the closest understanding may never cease to exist between our own country and restored and liberated Belgium.

DISCUSSION.

THE CHAIRMAN (M. Emile Cammaerts), in moving a vote of thanks to the author for his paper, said everyone present must have felt the eloquence of certain of the figures quoted in the paper. There was sometimes a prejudice in artistic and literary circles against figures, but when one heard of the fifty-four blast furnaces in Belgium in 1913 being reduced to one in 1917, and having already increased to eleven, he thought there were very few poems written about the resistance and struggle of the civilian population in Belgium during German occupation which were more eloquent or inspiring than those three figures.

H.E. THE BELGIAN AMBASSADOR (Baron Moncheur) said he felt sure he was voicing the sentiments of all Belgians present when he expressed to the author the feelings of deep gratitude evoked by his interesting paper. In fair days and in foul, Sir Cecil had shown himself the true and staunch friend of Belgium. For many years he occupied the important post of Consul-General at Antwerp, and during those years he witnessed the prodigious development of that great port. Personally he was convinced that the constant increase of the trade relations between Great Britain and Belgium was very largely due to Sir Cecil's untiring efforts. When Belgium was reduced to that pitiable state of ruin of which so heartrending a description had been given in the paper, the author never ceased to make full use of his great influence in the positions he occupied in London in order to help the Belgian Government in its difficult task of succouring the unhappy Belgians, who had been reduced to so pitiable a condition under the yoke of the tyrant enemy. It was the privilege of the Belgians to show their gratitude in a manner no less flattering than spontaneous by the hearty welcome they gave the author when, following close upon the victorious armies of the Allies, he returned to Antwerp, which had really become his second home. It was not to be wondered at that when the people of Belgium realised that the author was leaving their country for good they should have been really grieved, but, even now that he had retired to a well-earned rest after a long and strenuous career, he never ceased to show his kind solicitude and devotion to Belgium, especially in his capacity of honorary treasurer of the Anglo-Belgian Union. The author had indeed nobly and eloquently depicted the situation of Belgium, which had now risen again and set out full of hope and energy on the road to progress and prosperity, and the grateful hearts of her people would never forget the author's share in the great work of her national resurrection.

LORD ASKWITH, K.C.B., LL.D., said he desired to endorse, on behalf of those present who were of British nationality, the eloquent words which His Excellency had uttered with regard to the paper. The interesting collection of facts and lantern-slides presented showed in connected sequence the events that had taken place in Belgium

during the last five years. The author generally backed up his arguments by facts. He was a man to whom Londoners should be grateful for the way in which he brought before them the fact that it was necessary to darken their lights when the German aeroplanes came over, and it was largely due to his influence that London made, perhaps, the greatest mass effort of the war, when everyone watched his neighbour more carefully than he had ever done in his life before. There were two points in the paper on which he would like to say a few words. The slides that had been shown depicted some of the wonderful examples of destruction wrought by the Germans just before their leaving Belgium. Personally, he thought that was one of the most harsh things the Germans did—that, having made use of the country as far as they could during the war, they should, when they found they could not remain there any longer, have gone in for wanton destruction in order that the Belgian people might not be competitors with them after the war. When he visited Belgium last August, he went, on the advice of his namesake — who was now contesting Paisley, and who told him that the works were the most marvellous instance of scientific destruction he had ever seen—to the great factory founded years ago near Liége by an Englishman. He was taken by the head of the firm to a platform from which he was told he would see what had been one of the most up-to-date engineering shops in the world. He expected much, but not all that he saw—he did not expect to see such a mass of concrete foundations blown up by gelignite, of twisted iron and steel, of girders cut off in such a manner that no new engines or machines could be put upon those foundations or so twisted that they could not be dealt with in any way whatsoever. It was indeed a terrible sight, and the slides that had been shown that afternoon depicted destruction of the same nature that had been carried out in other places. The second point in the paper to which he wished to allude was the passage referring to the progressive movement in Belgium. He had the pleasure of visiting Belgium at the end of August and at the end of December, partly in connection with the work of the *lycée* in London for the education of Belgian children during the war, and partly in connection with the establishment of an Anglo-Belgian Y.M.C.A., which the Belgian people had taken up very actively, largely at the desire of their soldiers, for the benefit of the army. On his second visit he noticed that a very remarkable change of atmosphere had taken place since his visit in August. In August there was still some of the apathy engendered by the war, such apathy as might even now be seen in the devastated regions of France, and there was a feeling that the lack of raw materials would keep a large number of people unemployed for many months, particularly in the textile trade. Although the harvest was then being got in, with an extraordinary absence of reaping machines—which were seen in numbers, possibly taken from Belgium, immediately over the German border—there was not the same energy or movement as was apparent in December. In December it struck him that a great change had taken place. At Charleroi they were even indulging in a strike, which, however, the Prime Minister, M. de la Croix, successfully managed to settle. There was pleasure—mitigated, he feared, now—that the Belgian franc was even at a higher rate of exchange than the French, and there was a movement and a desire to go ahead and to determine that the Germans, in spite of their destruction, should not have the upper hand of the Belgians in trade and in commerce. Relying largely on the good offices and friendship of this country to help them where it was feasible, the Belgians were determined to advance on the road to prosperity and to the restoration of that stability which alone would enable them to make progress in the future.

Lord Emmott, P.C., G.C.M.G., G.B.E., said he had listened with the greatest possible interest to the extremely able and well-balanced description of Belgium which had been given in the paper, and wished to associate himself with the eloquent words of thanks which His Excellency had used in supporting the vote of thanks proposed by the Chairman. He had for long been connected with the Anglo-Belgian Union, and in the previous July he had the great pleasure of visiting Belgium with a number of those associated with the Anglo-Belgian Union, and saw the scientific destruction at the Providence Works, which had been so well described in the paper. He also saw many of the other places mentioned by the author, for the tour included a visit to Dinant, where the horrible massacres occurred. He was delighted to hear that a much more hopeful feeling existed in Belgium to-day than there was in July. He was hopeful then that the feeling would soon improve, and he was very glad to hear progress had been made since that time. On the one or two occasions when he had the honour of addressing Belgian audiences he took the liberty of saying: "We are doing all that we can to help in our little way and to see that you obtain raw material, and if you will only avoid labour troubles I do honestly believe that you may still have before you a very great industrial future, which will compare favourably even with your past industrial eminence." He also said one other thing, which he would repeat now: "I do wish that we could have brought with us in this deputation to Belgium a large number of British workers, who might see what war really means and what a devastated country is like, and who might appreciate how intensely anxious the great mass of the people of Belgium are simply to get to honest work again in order that they may be earning their living and feeling that the country is making some progress." He still wished that, because it was worth noting that, whilst our real obligation to Belgium was a moral obligation, yet entirely beyond that we had also a great immediate interest in seeing Belgium prosperous, as well as in seeing our Allies and the other countries of the world prosperous, in order that we might ourselves

do a mutually advantageous trade with them. A great many of the workers in this country did not understand how much one country was dependent upon another, how we prospered most when other countries prospered too. He thought the people of this country were rather too much inclined to look at their own affairs and to forget that we, with our world-wide trade, were dependent upon the rest of the world as well as upon what we could do for ourselves in our own country. He had the greatest possible pleasure in supporting the resolution of thanks to the author.

MRS. W. ROWLAND FISHER said it might be of some interest to those present to hear what the author had said corroborated by one who went over to Belgium in February last, only three months after the Germans had left the country. She and her husband were given passports before the general public, and went over on a refugee boat to Antwerp, taking with them twenty-three little Belgian girls who had been at a home in this country since the early days of the war. Belgium, at the time of her visit, was exactly as the author had described it. Antwerp was like a dead city—there was no traffic, everyone wore dark clothes, and the place seemed as though it had a blight on it. People who wanted to leave Antwerp by train had to arrive at the station three-quarters of an hour before the train started if they wanted to get into a carriage that had any glass in the windows, although there was snow on the ground at the time and the weather was very cold. After visiting Antwerp she went on to Louvain, Malines, Brussels and Dixmude. Dixmude, which had once been a prosperous city, was simply a heap of stones. The condition of that town, however, was the result of war, whereas the condition of Louvain was the result of wickedness. Every other house in Louvain, and in some cases whole streets, as well as the University, had been deliberately destroyed by the Germans. One of the Belgians said to her: "The difficulty in Belgium of getting straight is that everything is upside down, we have not got anything." In Northern France there might be more devastation, but the rest of the country was untouched; they had got some trains that were not smashed up, and some factories that were not destroyed; but in Belgium there was nothing. Of course that was some time ago now, and matters had been improving since then. One thing that struck her very much at the time was that the Belgians seemed to appeal so much to the English to help them to get straight again. She tried to tell them that England also had difficulties to deal with owing to the war, but of course the Belgians looked to England and the other Allies to help them. She still kept up a constant correspondence with the children and with their parents, who were all most grateful for the happy time the children had spent in England.

The resolution of thanks was carried unanimously, and a vote of thanks to the Chairman terminated the meeting.

THE BATTICK INDUSTRY IN JAVA.*

The Battick process is a dyeing process, with this restriction, however, that part of the cloth is made immune to the dyestuff beforehand, in order to form a design.

This method originates from the times when only vegetable native dyestuffs were available. This class of dyestuffs only gradually gives the right shade to the cloth, thus necessitating a long contact between cloth and dyestuff, which is quite out of the question when a printing method is applied. The battick process, however, allows the cloth to remain in the dye-tub as long as desirable.

Those parts of the cloth that should not come into contact with the dyestuff are simply covered with a wax mixture on both sides of the cloth.

On first class battícks, or on batticks made for private use, the wax figures are drawn on the cloth by means of a small instrument called "Tjanting." This consists of a reservoir which contains the liquid wax-mixture, and a small tube, which enables the operator to bring the wax on the cloth. The handling of the instrument therefore has some resemblance to painting.

The method above described, however, is not suitable for industrial purposes, because it takes too long to complete a battick. Generally, brass or copper stamps are used, which enable the workman to stamp in a very short time all wax figures, which are repeated regularly in the design.

Several nice old designs of historical value are known, but the demand for novelties, and the fact that a great number of Europeans and Chinese have become employers in this line of industry, have caused the production of innumerable new designs, which are, however, often very poor from an artistic point of view.

The principal materials for this industry are white cotton cambrics, imported from Europe in various qualities. In the last few years, however, grey supers are also more and more used instead of cambrics. This is to be put down to the high prices ranging nowadays for cambrics as a result of the prevailing circumstances due to the war. Formerly supers were exclusively imported from Europe, but as the Japanese industry is making more and more headway in this respect, now supers are also imported from Japan.

The white cotton cambrics are imported in various finishes, principally to be divided into soft, medium, and hard finish. Certain districts prefer a particular finish, depending upon the process followed by the workmen.

The principal purpose of the finish is to prevent the wax from coming into too close a contact with the cloth, as otherwise great difficulties are experienced in removing the wax afterwards.

In some districts the cloth is impregnated with a mixture of "djarak" or "katjang" oil, in consequence of which the cloth is said to absorb

* The information in this article has been supplied by Messrs. Geo. Wehry & Co., of Batavia, through H.B.M. Consul-General at Batavia, for the Director of the British Institute of Industrial Art.

the dyestuff more easily. When this process is followed, a pure finished cloth is preferred.

Imports of cambrics.—The following are the totals of bales imported into Sourabaya during 1914-18:—

1914 . . .	5,051 bales.	1,171 cases.
1915 . . .	6,167 ,,	1,773 ,,
1916 . . .	5,601 ,,	2,051 ,,
1917 . . .	4,575 ,,	971 ,,
1918 . . .	2,566 ,,	81 ,,

The figures mentioned above are taken from the Government statistics. These statistics, however, only mention the number of pieces. For this reason we have reduced the number of pieces of standard bales of—

300 15-yards pieces,
150 30-yards pieces, and
100 45-yards pieces.

The above figures only apply to the imports of Sourabaya. It should be borne in mind that in Sourabaya only two-fifths of the total imports of the whole archipelago are handled.

Wax used in the battick industry.—As a rule, no pure wax is used, but a mixture of mineral wax (one of the products of the paraffin oil refineries working in this country), animal fat, and rosin. The rosin is imported from America in large quantities, and so far imports have been sufficient to keep the industry going.

Dyestuffs used in the battick industry.—Two dyestuffs are of predominating importance, viz., *indigo* and *alizarine* red. The following table gives the imports in Sourabaya from 1914 up till May, 1918:—

	Indigo.	Alizarine.
1914 . .	161,670 kilos.	68,050 kilos.
1915 .	21,300 ,,	—
1916 . .	66,000 ,,	34,520 ,,
1917 . .	—	—
Jan.-May, 1918	—	—

This statement shows better than words can tell how abnormally small imports of dyestuffs have been during wartime. One might wonder how it has been possible, nevertheless, to keep the industry going so long. The high prices asked for all battick dyes have been of great importance in this respect, as they have forced the natives to work more economically.

At present, however, stocks of European dyestuffs are almost exhausted, and it is to be feared that within a few months the greater part of the employers will have to close their workshops. As a matter of fact, hundreds of the smaller employers have already stopped working at present.

The economical interests of the native population, as well as the selling possibilities for (principally British) white cotton cambrics make the problem of further supplies of dyestuffs a question of vital importance for everybody interested in this trade.

In some districts the native indigo has replaced to some extent the use of synthetic indigo. Great difficulties are, however, experienced, as dyeing with those vegetable dyestuffs takes much more time than is necessary when European indigo is used; consequently a quick production is impossible, which is an almost unsurmountable difficulty for the natives, working with a very limited capital. The native indigo will therefore prove to be unsuitable, at least on a big scale, as a remedy for the shortage of dyestuffs.

For alizarine the position is still much worse, as there are practically no other dyestuffs available which can replace the European alizarine to any important extent.

When going through the samples of batticks obtained from our Sourabaya office, for instance, it is noticed that not a single district in the Sourabaya territory can do without this dyestuff.

Without any doubt we shall see a heavy falling off in the turnover of white cotton cambrics within the next few months on account of the lack of stocks of alizarine.

There are still some other colours which are badly wanted, as *e.g.* yellow (aurimin and azoflavin), violet, and green. The quantities used of these dyestuffs are much smaller, but still the battick industry can hardly do without them. Especially the yellow dyestuffs (aurimin and azoflavin) are absolutely wanted.

We might mention here that several efforts have been made to obtain dyestuffs from England, United States of America, and Japan, but so far without any marked success.

The principal battick centres in the Sourabaya district are Toeloeng Agoeng (Residency Kediri); Kedong, Tjankring, and Bangil, near Sourabaya; Grissee, also near Sourabaya.

In all these places an extensive trade in batticks is carried on with the other parts of Java and the other islands of the Dutch East Indian Archipelago. Large quantities are also exported to Singapore, and hence distributed all through the Straits Settlements. As regards exports, the island of Madoera is of minor importance. This island only exports limited quantities to the Madurese parts of Java (Residencies of Pasoeroean and Besoeki). Still the Madurese batticks are of some interest, as both the process and designs are rather different from those in Java. Consequently Madurese batticks have a charm of their own, especially as they represent rather superior work.

With regard to West Java we might mention that the industry is of minor importance; only in the neighbourhood of Batavia are a few employers, but their output is comparatively small. They all imitate the designs of Solo and East Java, original designs being hardly manufactured in these parts.

We yet have to mention the imitation batticks, a product of the Dutch industry, which are imported here on a large scale. The European batticks are obtained by a simple printing process on one side only of the cloth. These printed imitations can easily be detected, as the colours are much livelier on the front than on the back. Generally European printers use the Pekalongan designs, as they are much beloved by the Javanese.

In the last few months Japanese imitations have appeared also in the Java market, but as these imitations are of a very inferior quality, so far they have not met with any success. It may be possible that the Japanese industry will produce a better article in times to come, but so far their imitations have been very poor.

COTTON-GLOVE INDUSTRY IN ST. GALL.

One of the most important and significant features of the introduction into Switzerland during the war of industries of which the Germans had a pre-war monoply, or a predominance at least, is that of woven, knitted or imitation suede cotton gloves. To the district in and around Chemnitz, in Germany, is due the credit of the inception of this industry and its gradual development to the extent that just before the war it had become almost a world monopoly. Ninety per cent. of the pre-war imports into Switzerland of these goods came from Germany, almost all from the Chemnitz district, the industry being at that time non-existent in Switzerland.

The materials for the manufacture of these cotton gloves in the Chemnitz district before the war were either imported in the form of yarns from the United Kingdom or were spun in Germany from Egyptian cotton. As the war progressed, the lack of raw materials no doubt reached a stage where the Chemnitz factories were obliged to suspend, almost entirely, operations in this line. Consequently, Switzerland's imports gradually diminished during the war.

In order to meet the local demand for these articles, writes the United States Consul at St. Gall, certain Swiss manufacturers investigated local conditions to see if it might be worth while to introduce the industry into Switzerland. The St. Gall district, which is almost entirely given over to the manufacture of cotton embroideries and kindred articles, was found especially adaptable; and in the spring of 1917 a Swiss firm of handkerchief manufacturers at St. Gall started a small factory at Rorschach on Lake Constance. As the industry was entirely new to Switzerland, it was necessary to secure machines and operators from the Chemnitz district. Accordingly the firm imported about ten knitting looms (known in Germany as Kettenwirkstuhl), which were especially adapted to the manufacture of these gloves. The firm secured also the services of an expert German foreman who had been employed for years in one of the largest of the Chemnitz factories. This man went to Switzerland in the spring of 1917, taking with him about forty German girls whom he had selected from various factories to train the inexperienced Swiss girls.

When the progress of the factory reached a certain stage the firm dispensed with the services of their German foreman, permitting him to be engaged by another St. Gall firm, which in October, 1917, had also organised a branch for the manufacture of knitted cotton gloves. As the first venture became more and more successful and its output gradually increased, the services of the German girl employees were dispensed with, their place being taken by Swiss girls.

The cotton used in the manufacture of these gloves is either Louisiana or Egyptian which is spun in England and runs in numbers from 60 to 90. The silk is purchased from Swiss firms.

The first-mentioned factory has two warping machines, which lay out warps having lengths of some 250 yards. The knotting looms produce a cloth having a width of 68 inches; and since each machine has a daily output of 37 square yards of cloth, and each square yard makes ten pairs of gloves, the daily production of the ten machines must be 370 square yards of cloth, from which are made approximately 300 pairs of gloves. At this rate the annual production is about 90,000 dozen. As the average weight of a dozen is about 300 grammes the factory must use approximately 200 lb. of cotton a day.

The cloths after production are dyed or bleached by local firms at Romanshorn, near Rorschach, the dye commonly used being black or beige. Each of the various machines used in the manufacture has its especial work, such as cutting according to size or shape of gloves, sewing on braid and buttons, making buttons, etc. The finished glove is subjected to a steaming process in a special apparatus.

The other St. Gall firm likewise have about ten machines and maintain forty employees. The output of this firm is about 100,000 dozen pairs a year, most of which are sold for domestic consumption.

During the year 1917 about 1,000,000 dozen pairs of suede cotton gloves were made in the United States, or about five times Switzerland's output in 1918. The industry has also been established in France during the last three or four years, several factories having been started at Grenoble. The textile expert of the French Vice-consulate at St. Gall, who has made a study of this industry, states that France will soon be able not only to produce sufficient for its domestic consumption, but will also be in a position to manufacture for the export trade.

From the fact that this industry has, within the last three or four years, been successfully introduced for various reasons in the United States, France and Switzerland, it would appear that the Chemnitz district which invented and cultivated this industry, has, for the time being at least, lost its monopoly and world control.

NOTES ON BOOKS.

Working Life of Women in the Seventeenth Century. By Alice Clark. London: George Routledge & Sons, Ltd.; New York: E. P. Dutton & Co. 10*s*. 6*d*. net.

With the object of ascertaining what were the circumstances of women's lives in seventeenth-

century England, Miss Alice Clark has, as "Shaw Research Student" of the London School of Economics, made a fairly exhaustive examination of the mass of historical material available for her purpose in the shape of domestic and public records of the period and contemporary literature in which the customs and manners of the day are unconsciously revealed. A list of authorities, occupying some dozen pages, sufficiently indicates the scope of her inquiry.

Her idea, we take it, is to trace the evolution of woman's industrial position under the blight of capitalism, and for this purpose she has chosen a transition period when the woman of affairs is still frequently to be seen side by side with the "lady of leisure," that new product made possible by rapidly increasing wealth, and so amusingly, if unedifyingly, depicted in the pages of the Restoration dramatists. Miss Clark's contribution to social history appears at a time when there is a reaction against the prejudice which excludes woman from public life, and when she is seeking to return, although under different conditions, to the honourable position of economic independence which she appears to have held in considerable measure in the early part of the period under review, and which she was only beginning to lose in the later part of the century. Industry at that time was becoming less and less an affair of the family and the home-work shop (where women could play their part without altogether abandoning household duties) and more and more the concern of wage-paying capital. Chapters are devoted to the aristocratic and *nouveau-riche* classes, to agriculture, to the textile trades, and to the crafts and trades, and in every class of society we find women still leading lives which, for fulness and productivity, compare very favourably with the lives of the majority of women in the first decade of the twentieth century. Idleness, however, was increasing in the wealthier classes, while at the same time in the sweated industries were to be found a large army of poorly-paid unskilled women workers. A chapter on the professions might perhaps have been omitted, as it only goes to show that although women might be particularly suited to be doctors, parsons and lawyers, they were rigidly excluded from these callings as soon as they became properly organised. The lesson which we think emerges clearly from these pages, though insufficient stress is laid on it by Miss Clark, is that woman lost her honourable position in the economic world when changed conditions demanded a specialised training which could not be had in the home. Women either could not or would not be trained. Quite possibly few could be spared altogether from the home, and it therefore seemed natural that facilities should be closed to them for training both in the trades and in the professions. The problem of the surplus woman was not then so urgent.

GENERAL NOTES.

EXPERIMENTS WITH PEANUTS IN MESOPOTAMIA.—An interesting account of a successful experiment which has been carried out at Fellujah, on the River Euphrates, about thirty-eight miles west of Baghdad, with peanuts (or groundnuts) has been furnished by the United States Consul at Baghdad. One of the most remarkable facts about Mesopotamian agriculture is the scarcity of oil seeds among the crops grown in the country. Practically no oil seeds are grown, with the exception of a little sesamum and linseed. In other Oriental countries oil seeds are quite commercial crops. India, for instance, has its linseed, cotton-seed, coconut, gingelly, rapeseed, sesamum and peanuts, while Egypt has its cotton and sesamum, and China its soy beans. Considerable interest, therefore, is attached to an experiment with peanuts carried out at the Fellujah Gardens. The plot was only a small one, about one-tenth of an acre being sown. The crop was sown in June and lifted in November. The person in charge of the garden had no experience of this crop, and sowed somewhat too thickly and overwatered, yet the crop when first lifted gave 2,550 lb. of nuts, which, when dried, gave 1,800 lb. per acre. Peanuts are already in considerable demand in the country, large quantities being imported from India. At present the nut is consumed in a parched state or is used for making sweetmeats. Later on, when the production exceeds this local demand, the surplus will find a ready export as an oil seed. The variety grown at Fellujah is a tight-husked variety, with a very attractive bright-red skin, known as the small Japanese. It was not known in Mesopotamia before, and local merchants who have seen samples have been much interested. It has the advantage of being quick growing, requiring comparatively little water, and being easy to dig. Demonstration plots at various centres were to be arranged for this year by the Agricultural Department, and it should be possible to establish this crop on a commercial scale in a short time.

CELLULOSE FROM ANHINGA FIBRE.—Attention is drawn in the *Bulletin of the Federation of British Industries* to the United States Official Commerce Report of November 15th, dealing with the potentialities of anhinga fibre. Anhinga is a Brazilian plant which is chiefly found along the banks of those rivers of Para whose slow current allows a soft mud bed for its roots. The plant constitutes the raw material from which cellulose, for the manufacture of linen paper, is obtained, and may also, under chemical treatment, be transformed into artificial cotton fibre. Experiments on a large scale were started last year with excellent results, and it is stated that a new process for dissolving the fibres has been discovered, which transforms them into very fine white fibres. These resemble cotton fibre of high quality, but are considered to

be superior to it, inasmuch as the lines of the anhinga fibre are straight and parallel. It is declared that the State of Para is capable of producing 100.000 tons of fibre for export annually, and a mill already in operation has a daily output of 600 kilos. The price of the fibre at Para is between 300 and 350 reis—roughly equivalent to 5*d.* in English currency—per kilo.

A PRODUCTIVE AUSTRALIAN GRASS-TREE.—A recent number of the *Weekly Bulletin* of the Canadian Department of Trade and Commerce contains a description of a species of Australian grass tree known as the "blackboy" tree, which flourishes in most parts of the continent, and especially in Western Australia. The peculiar interest of this tree, which grows to a normal height of from 7 to 10 ft., is the variety of commercial purposes to which it can be put. The tree contains gum in large quantities, and amongst other by-products extracted under treatment are tars (free from harmful acids), tarpaulin dressings, rope and sanitary tars, lacquers (such as Japan black), steam and refrigerating pipe lagging, paint for ironwork that requires stoving at high temperatures, stains, and paints; phenol, benzol and alcohols, coke, potash, and pyrogeneous acid. Although until recently no attempt has been made to utilise the tree commercially, a company has now been formed to extract and market its by-products. Not only have all the articles already enumerated been obtained, but the company also intend to produce dyes, perfumes and formalin, and various kinds of varnishes.

"CONSUTA" PLYWOOD.—Messrs. S. E. Saunders, Ltd., of East Cowes, the well-known builders of air and marine craft, have forwarded to the Society some specimens of their "consuta" plywood. The component layers, after being cemented together, are sewn through with rows of parallel stitching. It is claimed that this process gives to "consuta" a super-added strength and stability which make it the strongest and lightest material yet evolved. It has been used for the last twenty years in the construction of racing motor-boats, gondolas for airships, hulls for flying boats, etc. Hitherto the material has been handsewn, but it has now been found possible to produce the material by machinery and in commercial quantities.

SUGAR-CANE INDUSTRY.—The Kingston (Jamaica) correspondent of the "*Times*" *Trade Supplement* reports that this industry is booming in the largest of our West Indian colonies. "The transformation in some centres is remarkable. Large properties have been brought under cultivation, especially in the central section of the island. Bananas have given way to cane plants; large sugar factories have been erected, two of them being in operation, while a third—the largest central in the island—will be at work early this year." A scheme for the establishment of a Government central factory is under consideration.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

FEBRUARY 11.—LIEUT.-COMMANDER NORMAN WILKINSON, R.N.V.R., O.B.E., R.O.I., R.I., "Naval Camouflage." REAR-ADMIRAL SIR DOUGLAS EGREMONT R. BROWNRIGG, Bt., C.B., will preside.

FEBRUARY 18.—SIDNEY PRESTON, C.I.E., "English Canals and Inland Waterways." NEVILLE CHAMBERLAIN, M.P., will preside.

FEBRUARY 25.—JAMES CURRIE, C.M.G., Ministry of Labour (Training Department), late Principal, Gordon Memorial College, Khartoum, "Industrial Training."

MARCH 3.—WILLIAM JAMES GARNETT, First Secretary, H.B.M. Diplomatic Service, "Mongolia from the Commercial Point of View."

MARCH 10.—H. M. THORNTON, "Gas in relation to Industry and Housing." SIR ROBERT A. HADFIELD, Bt., D.Sc., F.R.S., will preside.

MARCH 17.—WILLIAM WORBY BEAUMONT, M.Inst.C.E., "Street Passenger Transport of London."

MARCH 24.—AIR-COMMODORE EDWARD MAITLAND, C.M.G., D.S.O., A.F.C., "The Commercial Future of Airships."

APRIL 14.—JOSEPH THORP, "The Fundamental Basis of Good Printing."

COLONIAL SECTION.

Tuesday afternoons, at 4.30 p.m.:—

MARCH 2.—G. F. SCOTT ELLIOT, M.A., B.Sc., F.R.G.S., "Trade Routes for the Empire in Africa." COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., will preside.

MAY 4.—PROFESSOR WILLIAM A. BONE, D.Sc., Ph.D., F.R.S., "Lignite."

Dates to be hereafter announced:—

CHARLES H. SHERRILL, "Stained Glass."

GRAILY HEWITT, "Rolls of Honour."

CHARLES CROWTHER, "The Arts and Crafts of Japan" (with examples from the author's private collection).

WILLIAM CRAMP, D.Sc., M.I.E.E., "Pneumatic Convoying Plants, with special reference to the Transport of Grain."

L. GASTER, "Industrial Lighting in its relation to Efficiency."

SIR VALENTINE CHIROL, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

BRIGADIER-GENERAL LORD MONTAGU OF BEAULIEU, C.S.I., "Roads and Transport in India."

SIR GEORGE CUNNINGHAM BUCHANAN, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

CANTOR LECTURES.

Monday evenings, at 8 p.m.:—

CHARLES FREDERICK CROSS, B.Sc., F.R.S., F.C.S., "Recent Research in Cellulose Industry." Three Lectures.

Syllabus.

LECTURE I.—FEBRUARY 16.—*Compound Celluloses.* (*a*) Lignocelluloses: (1) Jute: Heart damage of baled jute—Bearings on problems of constitution and formation, and on industries—Special treatment of jute and jute fabrics for decorative and "useful" applications; (2) Esparto: As a special type of lignification—New researches; (3) Woods: Lignification and de-lignification—Relations of lignone to their "aromatic" by-products. (*b*) Cutocelluloses, a special chemistry of raffia—The question of natural cellulose esters, and a technical ideal.

WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.

May 3, 10, 17.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 9...British Academy, King's College, Strand, W.C., 5.30 p.m. Ven. Archdeacon Charles, "The Apocalypse." (Lecture II.)

East India Association, 7A, Tothill-street, S.W., 3.45 p.m. Sir Harvey Adamson, "Burma."

Engineers, Society of, at the Geological Society, Burlington House, W., 5.30 p.m. Mr. B. Geen, "Presidential Address."

Geographical Society, Kensington-gore, W., 5 p.m. Captain H. A. Lloyd, "Characteristics of the Ground as Seen from the Air."

Brewing, Institute of, Imperial Hotel, Russell-square, W.C., 8 p.m. Mr. D. Brownlie, "Coal Saving by Scientific Control in the Boiler House."

TUESDAY, FEBRUARY 10... Royal Institution, Albemarle-street, W., 5 p.m. Professor G. Elliot Smith, "The Evolution of Man and the Early History of Civilisation." (Lecture III.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. 1. Mr. P. M. Crosthwaite, "Experiments on the Horizontal Pressure of Sand." 2. Dr. A. R. Fulton, "Overturning Moment on Retaining-Walls."

Oriental Studies, School of, Finsbury-circus, E.C., 5 p.m. Mr. A. D. Innes, "The Mogul Period of the History of India." (Lecture I.)

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 7.30 p.m. Mr. P. Waterhouse, "Happy Bondage."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Annual General Meeting.

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. The Secretary, "Report on the Additions made to the Society's Menagerie during the months of November and December, 1919." 2. Mr. R. I. Pocock, "Exhibition of Photographs of a Chinese Serow." 3. Mr. H. R. Hogg, "Some Australian Opiliones." 4. Dr. C. F. Sonntag, "Description of the Larynx and Œsophagus of a Common Macaque, exhibiting several unusual Features." 5. Messrs. R. E. Turner and J. Waterston, "A Revision of the Ichneumonid Genera *Labium* and *Poecilocryptus*."

Colonial Institute, Central Hall, Westminster, S.W., 8 p.m.

WEDNESDAY, FEBRUARY 11...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. N. Wilkinson, "Naval Camouflage."

United Service Institution, Whitehall, S.W., 3 p.m. Colonel F. C. Fuller, "The Tank Corps."

Literature, Royal Society of, 2, Bloomsbury-square, W.C., 5.15 p.m. Professor Sir Henry Newbolt, "English Narrative Poems."

Industrial League and Council, Carpenters' Hall, Throgmorton-avenue, E.C., 5.15 p.m. Right Hon. W. Adamson, "The Industrial Situation."

THURSDAY, FEBRUARY 12...Trained Masseuses, Society of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 6 p.m.

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Dyers and Colourists, Society of (Bradford Junior Branch). 1. Mr. H. Robinson, "The Fastness of Gambines." 2. Mr. J. Wraith, "The Finishing of Dress and Coating Fabrics."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. E. Conrady, "Recent Progress in Applied Optics." (Lecture II.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. R. W. Seton-Watson, "The Czecho-Slovak Republic."

Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Major K. Edgcumbe, "The Protection of Alternating Current Distribution Systems without the use of Special Conductors."

Historical Society, 22, Russell-square, W.C., 5 p.m. Anniversary Meeting.

FRIDAY, FEBRUARY 13...London Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Rev. E. G. O'Donoghue, "The Story of Bethlehem Hospital."

Royal Institution, Albemarle-street, W., 9 p.m. Professor W. M. Bayliss, "The Volume of the Blood and its Significance."

Malacological Society, Burlington House, W., 8 p.m.

University of London, University College, Gower-street, W.C., 5 p.m. Dr. T. Borenius, "Mediæval Art." (Lecture V.)

Astronomical Society, Burlington House, 5 p.m.

Automobile Engineers, Institution of (Graduates' Section), 28, Victoria-street, S.W., 8 p.m. Mr. F. R. Cowell, "Steering Gears."

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m. 1. Professor C. H. Lees, Presidential Address. 2. Sir Arthur Schuster, "Atmospheric Refraction during Total Solar Eclipses."

Auctioneers and Estate Agents' Institute, 34, Russell-square, W.C., 7.45 p.m. Mr. J. S. Motion, "Licensed Property."

SATURDAY, FEBRUARY 14...Royal Institution, Albemarle-street, W., 3 p.m. Sir Frank W. Dyson, "The Astronomical Evidence Bearing on Einstein's Theory of Gravitation." (Lecture III.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 16th, at 8 p.m. (Cantor Lecture.) Mr. CHARLES FREDERICK CROSS, B.Sc., F.R.S, "Recent Research in Cellulose Industry." (Lecture I.)

WEDNESDAY, FEBRUARY 18th, at 4.30 p.m. (Ordinary Meeting.) SIDNEY PRESTON, C.I.E., "English Canals and Inland Waterways." NEVILLE CHAMBERLAIN, M.P., will preside.

THURSDAY, FEBRUARY 19th, at 3 p.m. Conference on House Furnishings at the Ideal Home Exhibition, Olympia. The RIGHT HON. SIR AUCKLAND GEDDES, K.C.B., M.P., President of the Board of Trade, will preside. (See Notice below.)

Further particulars of the Society's meetings will be found at the end of this number.

CONFERENCE ON HOUSE FURNISHINGS.

The Council have arranged to hold a Conference of Manufacturers and Distributors of House Furnishings and of others specially interested in the subject, in connection with the Ideal Home Exhibition at Olympia on Thursday, February 19th, at 3 p.m.

The chair will be taken by the Right Hon. Sir Auckland Geddes, K.C.B., M.P., President of the Board of Trade; Sir Henry Trueman Wood, Chairman of the Council of the Royal Society of Arts, and Sir Frank Baines, C.B.E., M.V.O., Principal Architect of H.M. Office of Works, will also speak, and thereafter the meeting will be invited to take part in a general discussion.

The main object of the conference is to initiate a scheme whereby the manufacturers and distributors in the different industries concerned may have an opportunity for interchanging views with regard to the development of their trades as to both quality and quantity of production. The Society has already convened conferences of manufacturers and distributors in other industries, as an outcome of which standing committees have been formed which will meet from time to time to discuss questions affecting the interests of the trades concerned. It is believed that these will serve a very useful purpose, and in a similar way it is hoped, after the general conference at Olympia, to hold special conferences of manufacturers and distributors of the various articles used in house furnishing.

Fellows of the Society desiring to attend the conference are requested to communicate with the Secretary, who will be glad to forward to them cards of admission to the Exhibition.

NINTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 11th, 1920; REAR-ADMIRAL SIR DOUGLAS EGREMONT R. BROWNRIGG, Bt., C.B., Chief Censor, Admiralty, 1914–18, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Barker, Sir Francis H., London.
Binns, A. S., Winnipeg, Canada.
Bowring, Edward John, Winchfield, Hants.
Cadbury, L. J., Northfield, Birmingham.
Ferguson, Louis, Port Glasgow, N.B.
James, Albert Alfred, J.P., Edgbaston, Birmingham.
Kelman, George Arthur Duff, London.
Mann, G. L. C., West Guildford, West Australia.
Mason, Rev. W. A. Parker, M.A., F.R.Hist.S., Manchester.
Mather, Right Hon. Sir William, LL.D., M.Inst.C.E., Bramshaw, New Forest.
Morris, Wing-Commander Alfred Drummond Warrington, R.A.F., C.M.G., O.B.E., London.
Naylor, Heaton, Rawdon, near Leeds.
Notley, Fenton George, Maclean, New South Wales, Australia.
Phillips, Grevile Herbert, Hereford.
Robinson, Commander Samuel M., U.S. Navy, San Francisco, California, U.S.A.

Rogers, John H., London.
Taylor, Alfred, York.
Thomas, Frank, London.
White, Tyndale, Brentwood, Essex.
Wright, Francis, Vancouver, B.C., Canada.

The following candidates were balloted for and duly elected Fellows of the Society:—

Cameron, Alexander, Sunderland.
Campbell, Archibald Jack, Dalmuir, Scotland.
Subedar, Ardeshir Rustumji, Bombay, India.

A paper on "The Dazzle Painting of Ships" was read by LIEUT.-COMMANDER NORMAN WILKINSON, R.N.V.R., O.B.E., R.O.I., R.I.

The paper and discussion will be published in a subsequent number of the *Journal.*

PROCEEDINGS OF THE SOCIETY.

EIGHTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 4th, 1920; SIR EDWARD W. BRABROOK, C.B., F.S.A., in the chair.

The paper read was:—

THE ENGLISH LANGUAGE AND INTERNATIONAL TRADE.

By ALFRED E. HAYES,

General Secretary, English Language Union.

If there is at this moment one human aspiration more universal than any other it is the eager hope that humanity may escape as quickly and as safely as possible from an age of chaotic conflict and waste into a new era of co-operative economy and social and international goodwill. If there is one conviction which the great world-war has driven deep into the hearts and minds of men it is that an essential unity of interest governs the relations of humanity.

In his Raleigh Lecture on "World History," delivered before the British Academy last October, Lord Bryce thus justified his topic: "The subject seems not unfitted to that strange phase, critical beyond all precedent, through which we, with the other civilised nations, have been passing. For the first time in the annals of our planet its inhabitants have become one whole, a community each and every part of which is affected by the fortunes of every other part . . . many forces, non-political even more than political . . . had been drawing the nations together. But it was the outbreak of war that first made us realise how mankind had virtually become one community, all the members whereof were to be thereafter linked together. Except as respects the loss of their citizens in war and the devastation of their territories, some of the neutral nations suffered, and some are indeed still suffering, almost as much as the belligerents. There followed a phenomenon rarely noted before, a formidable rise in prices, with a corresponding rise in wages, in every civilised country. The contagion of excitement and of strange doctrines accepted under excitement has spread far and wide. Thus have all men been forced to feel that the parts of the world have grown into one, for weal or for woe; thus comes it that now for the first time the history of the world in the full sense of the word can begin to be written."

Lord Bryce went on to specify and to examine, with characteristic catholicity and clarity, the "processes and the forces whereby races, tribes, nations and states have been, or are being, drawn together into one common life commensurate with the earth which they inhabit." Of these forces and influences he named three as supremely active—Conquest, Commerce and Religion—and touched tentatively upon "a new force which might, if brought into effective play, profoundly modify the relations of peoples to one another . . . the uniting into one body all over the world . . . of the hand-workers, or so-called 'proletariate.'" Of the unifying influence of philosophy, literature, physical science, and other related forces, Lord Bryce deemed it needless to speak to such an audience as the British Academy, and hazarded the prediction that some centuries hence ten languages may be spoken by more than nineteen-twentieths of mankind.

It would be an interesting task to attempt to estimate in what relative degrees the forces referred to by Lord Bryce have been responsible for the present geographical distribution of languages. Discovery, conquest, commerce and religion have all played their parts, concurrently or sequentially, in fixing the speech-areas of the world. In the two Americas, in the greater part of Africa, in Northern Asia, in Australasia and the Pacific Isles, discovery led the way for missionary zeal, for settlement and for conquest, while commerce followed in their train. In India trade opened the gates to conquest and the unifying influences of the British domination. In China and Japan commerce, calling in the aid of arms, broke through the barred and bolted doors that had for centuries shut in their teeming millions from contact with the Western world.

If discovery and conquest have coloured the

language-map over vast but thinly-peopled regions of the earth it is the more permeative influence of the personal contact of the trader, and of the missionary of religion, philosophy, science or education—served in these later days by almost miraculous and constantly advancing means of transport, transit and communication —that has broken down, and is daily breaking down, with cumulative energy, the barriers of racial, national and linguistic isolation, alike in the old world and the new.

And if the Briton has, in the past, played a master-part in these processes, it is due to those national characteristics of which Emerson wrote with such luminous sympathy in Victorian days—to that happy combination of physical vigour and mental complexity which have made him so pregnant a paradox in the history of the race. His constitutional vitality, bred and braced by a boisterous climate, has driven him to and through the waste spaces of the earth. His Celtic, Teutonic and Latin ancestry has woven for him a cerebral texture which, while displaying apparent contradictions and seeming insincerities very confusing to the foreigner of more homogeneous heredity, has not infrequently given him that combination of robust intellectual independence and catholic sympathy, that union of imagination and capacity, that practical idealism, which have, at so many stages in our history, championed the cause of human freedom, and inspired and guided those political and social adaptations to which the progress of ordered liberty owes so much.

It is to this peculiar quality of universal appeal and application that so many voluntary world-wide organisations, striking easy root in widely-differing nations, owe their birth in these islands.

I refer to this phenomenon not in any spirit of national egotism but to emphasise the fact that the world-wide influence of our people is not entirely due to Machiavellian diplomacy, and to discount in advance the criticism that any efforts we may put forth in the future to extend the use of the English tongue are due, not to a spirit of world-service, but to deep-laid plans for political preponderance and commercial advantage. The supremacy of the French language in diplomacy and of the English tongue in trade is due to no direct action on their behalf, but is merely the accidental accompaniment of the operations of the national character and genius in their special fields.

Indeed, it is precisely these two nations which have given the most hospitable reception and the most enthusiastic advocacy to those artificial languages which, since the era of maritime discovery and the intellectual renascence, have sought in swift succession to meet the world's need for a common speech. It was an English bishop and phonetician, John Wilkins, who in 1668 constructed the first of the so-called "philosophic" languages; and the most comprehensive history of all these efforts, combined with the most brilliant and powerful plea for this "artificial" solution of the problem, is the work of two Frenchmen, MM. Couturat and Leau. It is in England and France that Esperanto finds its most numerous adherents.

I cannot here enter into a full discussion of the rival claims of "artificial" and "living" tongues. I agree with M. Paul Passy, who, in reply to a correspondent, Mons. Clédat, wrote some years ago in *Le Maitre Phonétique*, the organ of the International Phonetic Association: "As for us, we shall show that the international language ought to be a 'living' language; the problem becomes more and more circumscribed and its solution approaches." Over seventy artificial languages have been thrust upon the notice of the world since John Wilkins' day. It has been a mournful waste of energy. Every such language yet constructed has been rapidly followed by others claiming superior merit. Zahmenoff's Esperanto was born in 1887. It has at least ten later rivals, and, although it has been "boomed" with a lavish expenditure of energy and money its users all the world over would not displace the population of a London borough. The solution certainly approaches, but it will be a solution in accord with hard facts. Quite apart from the populations of the English-speaking lands, with their opportunities for vast expansion, for every foreigner who can be converted to the use of Esperanto many thousands are born who, under the pressure of commercial necessity or the spur of cultural ambition, will learn the English tongue. Yet, while the neglect of the study of English in our universities and schools is a by-word and a reproach, British educational authorities are spending public money at the bidding of a handful of misguided fanatics on this doomed futility of an artificial speech. As for fostering the study of English abroad, as Mr. H. G. Wells has said in his "Anticipations," "There is no sign that either the English or the Americans have a sufficient sense of the importance of linguistic predominance in the future of their race to interfere with natural

processes in this matter for many years to come." It is among foreigners that one finds the greatest interest in English as a world-speech. Quite recently the Board of the Peace Congress of the North reported that in reply to its inquiry twelve out of nineteen university professors were opposed to any artificial language, and voted for English as the International tongue. Of the remainder, two were for French, one for German, one for Esperanto, and three for Ido.

A far more important plebiscite was conducted in 1903 by Mr. Gudmund Schütte, the Danish editor of the *Godlansk Budstikke*, and I was present at the meeting of the Teutonic Philology Society in Copenhagen at which the results of the inquiry were declared and discussed. I have before me the full list of the votes cast, and they show an overwhelming majority in favour of English, and include not only the names of distinguished authors, editors, publicists and traders, but professors and teachers of German, French and other languages. In the case of the greater nations the major pressure in favour of English is commercial, but with the smaller nations some such choice is in addition an intellectual necessity. Mr. Wells has well described their dilemma in his chapter on "The Conflict of Languages" in that volume of predictions to which I have already referred. He says: "The native of a small country who knows no other language than the tongue of his country becomes increasingly at a disadvantage in comparison with the user of any of the great languages of the Europeanised world. For his literature he depends on the scanty writers who are in his own case and write, or have written, in his own tongue. Necessarily they are few because necessarily with a small public there can be only small subsistence for a few. For his science he is in a worse case. His country can produce neither teachers nor discoverers to compare with the numbers of such workers in the larger areas, and it will neither pay them to write original matter for his instruction nor to translate what has been written in other tongues . . . In the matter of current intelligence the case of the speaker of the small language is still worse. His newspaper will need to be cheaply served, his home intelligence will be cut and restricted, his foreign news belated and second-hand. Moreover, to travel even a little distance, or to conduct anything but the smallest business enterprise, will be exceptionally inconvenient to him. The Englishman who knows no language but his own may travel well-nigh all over the world and everywhere meet someone who can speak his tongue. But what of the Welsh-speaking Welshman? What of the Basque and the Lithuanian who can speak only his mother tongue? Everywhere such a man is a foreigner, and with all the foreigner's disadvantages. In most places he is for all practical purposes deaf and dumb. The inducements to an Englishman, Frenchman or German to become bilingual are great enough nowadays, but the inducements to a speaker of the smaller languages are rapidly approaching compulsion. He must do it in self-defence. To be an educated man in his own vernacular has become an impossibility. He must either become a mental subject of one of the greater languages or sink to the intellectual status of a peasant."

The bogey of international jealousy which is so often stuck up by the advocates of an artificial *lingua-franca* to deter the English-speaking peoples from their plain duty derives no support from the nations whose susceptibilities they so tenderly consider. If one desires to find evidences of language-jealousy one must seek the bitterest examples among the rival supporters of artificial tongues. All serious testimony goes to show that personal advantage or intellectual interests decide the choice of language-study without regard to patriotic sentiment. "The action of the force of attraction of the great tongues is cumulative. It goes on, as bodies fall, with a steady acceleration." In the case of English it is becoming day by day more irresistible. National sentiment did not deter Bismarck from opening in English the Berlin Congress of 1878, nor the British and American representatives from speaking French at the recent Peace Conference in Paris. Practical utility alone will guide the choice of an international speech, and every day brings fresh proof that the choice is virtually no longer in doubt. Mr. Barnes, the representative of the British Government at the International Labour Conference at Washington, the most important industrial gathering ever held in the world's history, tells us in the *Observer* that "a remarkable feature of the Conference was the extent to which English was spoken by the delegates. In the case of India, Japan, China, Siam and Persia, all their delegates spoke English, many of them fluently. This simplified proceedings immensely. There was no language difficulty, so to speak. French and English were the two official languages, and only one delegate, an Italian Workers' representative, used his native tongue. This widespread know-

ledge and use of English is a hopeful sign that our language is becoming the diplomatic as well as the commercial language of the world."

There is no need here to emphasise the place which the study and use of English occupies in India and the Far East. Mr. Hartog's brilliant survey of Indian education in his recent paper read before this Society adequately presents the facts and points the moral. In Japan there has been for some years a large and influential English Language Association, composed mainly of teachers and presided over by Professor Okakura. In China, where English has been for so long the language of international trade, there has lately been a large extension of compulsory English in the schools. Of Scandinavia I shall speak in greater detail later on. Coming nearer home, in Holland a group of teachers has formed a "Peace by English League," whose objects are declared to be "to make the English language the world language, read by every civilised man and used for all correspondence." In Belgium Dr. Charles Didier has founded, under the highest auspices, an "English-speaking Association," which advocates the adoption of English as "the auxiliary language for all Belgians."

Even from Germany comes the same decision and demand. In the November-December issue of *Die Frau im Staat*, a monthly journal published in Munich, Hellmuth von Gerlach writes:—

"In my youth the first world language, 'Volapük,' was produced by the Swiss Schreyer. The idea interested me keenly; I ordered his text-book and commenced with pleasure, since one could master the rudiments of this language in a few days. However, I did not arrive at any practical use of it since it held little interest as a world language.

"Volapük is long since forgotten. I began to get theoretically interested in Esperanto and I soon decided to commence its study. Then Püus (Reichstagsabgeordneter) assured me that 'Esperanto has been superseded by Ido! Ido is the only world language. Learn Ido!'

"Most people do not realise the importance of a world language, whether it be Esperanto or Ido or Esperantido. To have a number of world languages is absolute madness.

"The world-language movement has gained new meaning through the Völkerbund (League of Nations). For the first time in the history of the world a real centralisation of the peoples has been conceived; although only in embryo something may come of it. One of the tasks of this centralising of the peoples will be a medium of understanding for all nations. Whoever thinks anything about the International Congress knows the importance of a commercial language. Where there are only educated people it is immaterial which of three or four languages be used, but this is a rare exception. Almost invariably translations follow; these hinder the progress of commerce and often bring failure in their wake.

"We need an international language! The question only is, which shall it be?

"I maintain that it is superfluous to create a world language. Under the ægis of a League of Nations it would be better to choose one of the existing languages. This language should be obligatory in all the higher and middle schools in the world.

"The language which seems to me most worthy of consideration on practical grounds is English. It has developed of itself, so to speak, into a world language, in the form of 'pidgin' English. It means much to the traveller to be able to make himself understood by the natives in 'pidgin' English as well in Eastern Asia as in Africa.

"When going to West Africa in 1912 I learnt out of hand the elements of 'pidgin' English in two hours. For those who know English it is mere child's play—200 words, partly good English, partly corrupted, without either conjugation or declension; but quite a raw, clear, comprehensible language. Among all the countless negro tribes, each of which has its own language, one can always find a couple of natives who were once on the Coast and there learnt 'pidgin.' I could use it equally well in the English or German Colonies.

"A supplemented 'pidgin,' or, what is the same, a simplified English, would be the ideal world language. No language with literary ambitions. For Heaven's sake no seeking after an 'artistic' world language! No, exclusively a practical medium of understanding. Pure utility must decide, the 'æsthetic' to be put aside.

"Our England haters, there is a sufficient number of them, will cry 'Zeter' and 'Mordio' at my project. If we want to emerge from the wreckage we must bar all sentiment and work out our policy with cool heads.

"Perhaps internationally-thinking Germans will oppose the 'sacrifice.'

"But the sacrifice is not greater for us than for the Italians, Spaniards, Danes, Russians and French. Especially the French! Even up to to-day it is the diplomatic language and the world speech of statesmen. It would mean a sort of dethronement for the French if the League chose English as the medium of understanding. I know how hard it would be for the French to resolve upon the sacrifice. They love, and rightly so, their language, which was chosen above all others as the politically æsthetic one.

"Yet, I demand the sacrifice even of the French! Practical points of view alone will have to decide.

"Not because English stands higher than other languages has it the birthright as a common language. No, but because through the needs of life itself has it become the medium of understanding in the greater part of the world.

"No one can contest the right to the mother language more keenly than I. It is our sacred kingdom of pure gold. But all peoples need an international medium of understanding, and this should be the English language."

Of the eagerness of our other late enemies, the Bulgarians, to displace German educational leadership by British, Captain Harold Goad gave us an excitingly eloquent account in the *Fortnightly Review* of November last. From this I cannot forbear to quote, if only for the lesson it conveys of the immense importance of a definite abandonment of our national attitude of indifference to the fortunes of our language. He says, in support of his plea for the establishment of British institutes in the Balkan countries :—

"The next question, then, is to consider what channels for the diffusion of English ideals and English teaching could be most effectively adopted. As an example, let us consider the case of Sofia, where I was stationed with the Allied troops of occupation from November until July, with every opportunity of studying the educational and social conditions of the Bulgarian people.

"When we arrived the town was full of German books, and almost every educated person spoke and read German. German culture and German ideals were for most Bulgarians their only conceptions of European civilisation. History, art, literature, drama, were widely studied with characteristic earnestness for self-improvement; but German text-books almost exclusively were used. Nevertheless, it was obvious to all that closer acquaintance with German militarism during the previous two or three years had caused the great majority of Bulgarians to loathe the arrogance of the German soldiery, while the prestige of the German system has collapsed with its defeat.

"The French staff immediately set about importing into the country French literature and French ideals. A Hachette library was established and the Bulgarian branch of the "Alliance Française" was revived, under whose auspices an excellent review was founded, and lectures in French upon the French language and literature were given periodically.

"Judging by the few I attended, these lectures were extremely popular; they were held in the great concert hall of the Bulgarian Officers' Club, which was crowded with all the best-known people of Sofia.

"In the month of May the 'English Speaking League' of Sofia was resuscitated by Bulgarian initiative. At its first meeting, I am told, there were only some four or five Bulgarian ladies present; but undaunted by the smallness of their numbers, these apostles of English culture resolved to hire a fair-sized house as the meeting-place of the league, and to announce in the newspapers the next meeting for a fortnight later.

"At this meeting there were, I suppose, a hundred people present, all conversing together in English, the great majority being old pupils of Robert College at Constantinople. They were all immensely keen on making the league a success. They agreed that the first requisite was a library of English books—literature, history, and the best fiction. They agreed that there ought to be courses of lessons in English, and lectures on the British Empire, and on English life and literature. They thought that the institute should be modelled on the 'Alliance Française,' and were sure that the similar German societies would be re-opened as soon as circumstances would permit.

"Surely, if such is the desire of Sofia, the capital of a defeated enemy, to know more of England, that of our Allies of Belgrade, Athens, Bukarest, and Salonika, could be no less great."

Captain Goad quotes in the same article the appeal of Professor Guido Ferrando and his Italian and English associates for further support for the British Institute in Florence, which has done so much during the war to promote understanding and friendship between the two nations. Captain Goad's vigorous and quite moving advocacy of the establishment of British institutes in Southern and Eastern Europe raises the whole question of how we may, with the greatest economy and efficiency, promote the study of English abroad.

The desirability of establishing British institutes in foreign countries was first suggested to me fourteen years ago by Mr. Sophus Madsen-Mygdal, headmaster of the large boarding-school in West Jutland at which was held the first Danish State's Holiday Course in English, to which I shall presently refer. Mr. Madsen-Mygdal, impressed by the result of our experiment, proposed the foundation of a permanent institute at some attractive centre, staffed and equipped for the continuous and developed application of the methods we had found so successful. I did not then think the time ripe for so adventurous an enterprise, and the matter dropped. I have since regretted it. As a result of the awakening effects of the war similar suggestions have emanated from highly authoritative quarters. Last January Dr. Gardner, in the absence of Professor Sir Bernard Pares at Vladivostock, read a paper by the latter at the Educational Conference which took place last January under the auspices of the Russo-British Bratsvo (1917), over which Sir Paul Vinogradoff presided. In his memorandum Professor Pares propounded a somewhat elaborate and rather costly scheme for the establishment of a British institute at Moscow. Sir Bernard estimated the foundation cost at £20,000, and proposed that the British Government should find most

of the money. In support of his scheme Sir Bernard said: "I am deeply convinced that the answer to German propaganda by intrigue is British propaganda by education. This is a fact which has impressed itself far more strongly on Russian public men than is realised in England. As Germany has broken down Russia, it will be our task, more than that of any other country, to build her up. This is not only a primary interest to us as desiring no territory and no domination in Russia, and not wishing that of any other Power; it is a task which is devolved upon us by Russian instincts which turn to us for models in the creation of a people's Russia, to our political past, to the broad line of our literature and education, and to our principles of commercial exchange; and, unlike other foreign influences, the success of British activity in Russia will be as great in the country districts as in the town. For these reasons there will sooner or later be a fine and self-rewarding career open to Englishmen familiar with the detail of social and educational questions, in the service of a free Russia; and such work will be the more effective service to British influence there. In particular, in the history of peoples, the English possess a record of free self-development such as Germany does not possess, and will certainly be called upon to supply models to Russia; and I therefore, as from the outset, desire to associate closely with the work of the Workers' Educational Association."

The institutes suggested by Captain Goad are of a much less ambitious character than that proposed for Moscow by Professor Pares, and would cost, according to his estimate, only about £2,000 to establish. We have to remember, however, that the utility and influence of an institute fixed in one centre must necessarily be largely limited to the locality, and valuable as such centres might become my own experience inclines me to the view that the money would be more fruitfully employed in more fluid arrangements: that an institute is more in the nature of a superstructure than a foundation. It seems to me to be more necessary at this juncture to stimulate and assist the study of English over wide areas through the ordinary educational machinery of the country than to establish centres of specialised or academic scholarship. There exist in every country varying numbers of persons already engaged privately or officially in teaching English. If these teachers could be brought together in voluntary association they would be able to determine and demand exactly that form of assistance of most immediate service. They would also exercise a formidable collective influence on public interest in their work and its significance, and pave the way for official administrative advance. Institutes, elementary and academic, would then spontaneously arise from natural necessity, and would be of indigenous origin and character.

For such spade-work as I suggest a "Travelling Scholar" appears to me to be the most economical and effective. And he would not only be a propagandist for English abroad but he would return to his own country with a knowledge of and sympathy for the people among whom he had been living—an interpreter of them to his fellow countrymen, of incalculable value to the cause of international understanding and co-operative goodwill. Will you forgive me if, moved, not by egotism but by a simple desire to convince, I indulge in a personal narrative? I regret that I must draw my illustration from my own experience, but I shall hope for your charitable interpretation.

It is now nearly fifteen years ago since I made the first definite attempt to create an English Language Union, which should render to our own world-wide tongue similar service to that enjoyed by the French language through "L'Alliance Française," and "German" from the German Language Association.

That attempt arose from an apparently accidental incident. In 1903 I was sent out as a "Travelling Scholar," by the London School Authority, to make a year's study of Danish education. Soon after my arrival I interested myself in the teaching of English in the schools, going into the class-rooms, giving lessons, talking and reading with the scholars, and giving the teachers what information and advice I could to assist them in their work. I found that this practice immensely stimulated the interest of the pupils in their study of the language. I also inquired into the methods adopted by the Danish Government to assist their teachers of the language to keep themselves fresh and up-to-date. I found that the Danish Rigsdag made quite generous provision to enable a certain number of teachers to visit England for about a month. But there was at that time practically no organised help on this side, and too frequently these visits were of very limited value. I wrote to Dr. (now Sir Frank) Heath, then at the head of the Board of Education's Office of Inquiries and Reports, making certain suggestions for the better reception and assistance of these in-coming foreign

students; and, although my plans were not followed in their entirety, Dr. Heath's action led to the establishment by the London University of its present Summer Courses in English for foreigners.

My interest in the teaching of English in Denmark reached the ears of Professor Rönning, Chief Inspector of the Danish Middle and "Real" Schools. He asked for a conference, and we met at Tarm "Real" School in the west of Jutland. There he made the suggestion which, more than anything else, lies at the root of the admitted success of the Danish State's Summer Holiday Courses in English. Professor Rönning's idea was that it would be a cheap and effective plan to assemble in a large boarding-school in Denmark about twenty-five Danish teachers of English, and to bring over to them a small English staff. Staff and students could live a communal life, rigidly excluding the use of the Danish language, studying, eating, and playing together, and enjoying the close intimacy and mutual helpfulness of a large family. He asked me to draw up a scheme for such a course, and to direct it if a grant could be obtained for the purpose. The interest of the Minister of Education (His Excellency J. C. Christensen, afterwards Prime Minister) was secured, a temporary and experimental grant was voted by the Rigsdag, and I was commissioned to appoint an English staff and to lead the course.

The experiment was carried out in the summer holidays of 1904. Twenty-five teachers of both sexes were selected by Professor Rönning to be the first students, and there were distinguished educationists as guests. Before the course closed the students sent an enthusiastic telegram of thanks to the Minister of Education for the privilege he had given them. The Rigsdag unhesitatingly voted the money every Budget until the outbreak of the Great War. In the third year, at the instance of Professor Jespersen, the grant was doubled to enable the teachers of English in the Gymnasier (Higher, Secondary and Public Schools) to have a course on the same model. The next year the teachers of German demanded a course on similar lines. The Rigsdag voted a grant for a German Course every alternate year —ours remaining annual. The State's Course has, during the ten years of its existence, completely justified itself in the opinion of the Danish authorities and people. It has been visited by experts from Russia, Norway, Sweden and Finland.

Very early during the first course I realised its immense value as a means of influencing Danish opinion respecting Britain. English is compulsory in all the secondary schools, and is taught in some of the primary and continuation schools of the capital and important seaports. Every scholar spends several hours a week with his "English" teacher. These boys and girls are, in a few years, the men and women of the best educated, most articulate and most influential sections of the community. The dynamic enthusiasms born at our course are conveyed day by day, year after year, to succeeding generations of the upper and middle-class youth throughout the whole country. And youth takes its magic home!

From the moment that I recognised the efficiency of this instrument for the promotion of international goodwill, I gave solicitous attention to the factor of personality in the selection of my colleagues, and I here register my deep gratitude for their splendidly capable, sympathetic and devoted service—service which has built up for this course a unique tradition, full of mutual international affection and esteem. Every list of lectures, every item of our daily programme, was considered and reconsidered, so that the very utmost might be done to render to the Danish and the British peoples the utmost mutual service—to remove misconceptions and misunderstandings, to modify opinions and to stimulate goodwill.

The State students have themselves created —and themselves manage—an Old Students' Association, which keeps up the old spirit of affectionate comradeship. It holds an annual meeting and festival in Copenhagen.

It is practically an English Language Association in Denmark. It forms English Study Circles, and links them up for mutual help. The result is that there are now, in over one hundred towns and hamlets scattered throughout Denmark, centres of English culture and influence.

The Old Students have also formed a Circulating Library of English Publications, available for every member for the mere postage.

The cost of the course falls entirely upon Denmark, and was before the war a trifle of about £200 a year. Not a penny of money nor an ounce of influence has been contributed by this country.

This work is not temporary and fugitive. It is permanent and cumulative. It is native in its origin, growth and control. It is purely

educational, and is absolutely free from any other aims than those herein expressed.

Is it to be wondered at that, perceiving its potency, I should return from this course filled with a vision of a great English Language Union, establishing such organisations in every foreign State, and using the world-wide knowledge of our tongue as a means of bringing the nations together in a spirit of friendly, fruitful mutuality?

But no efforts that I could make through ten long years availed to break down the indifference of either the public official or the private citizen to the splendid possibilities that seemed to me so clear and so inspiring.

Then came the Great War, and that unparalleled catastrophe shook the minds of men out of the deadly apathy of years.

The insidious and unscrupulous propaganda of Germany, the revelations of her "peaceful penetration" for aggressive ends shocked the nerves of every nation. Now I felt the time had at last arrived when something might be done. I submitted my plans to the British Government, to Foreign Embassies and Legations, to Anglo-Foreign Societies, to University professors, etc., and in each and every instance the methods and principles of the work carried on for so long in Denmark were cordially approved. Thus have been laid the foundations of the English Language Union, a union which, if adequately supported, may repeat the story I have just related in every country in the world to the immense advantage both of international understanding and international trade.

Mr. H. G. Wells, in his book "The World Set Free," predicts, you will remember, the outbreak of a great world-war a generation later than it has actually occurred, and gives us his equivalent of the League of Nations in the Council of Brissago. It is interesting to read now his prophecy of the adoption of the English language as the world-speech and the subsidiary changes which accompanied it. He says:—

"It is characteristic of the manner in which large enterprises forced themselves upon the Brissago Council that it was not until the end of the first year of their administration, and then only with extreme reluctance, that they would take up the manifest need for a *lingua-franca* for the world. They seem to have given little attention to the various theoretical universal languages which were proposed to them. They wished to give as little trouble to hasty and simple people as possible, and the world-wide distribution of English gave them a bias for it from the beginning. The extreme simplicity of its grammar was also in its favour.

"It was not without some sacrifices that the English-speaking peoples were permitted the satisfaction of hearing their speech used universally. The language was shorn of a number of grammatical peculiarities. The distinctive forms for the subjunctive mood, for example, and most of its irregular plurals were abolished; its spelling was systematised and adapted to the vowel sounds in use upon the Continent of Europe, and a process of incorporating foreign nouns and verbs commenced that speedily reached enormous proportions. Within ten years from the establishment of the World Republic, the New English Dictionary had swelled to include a vocabulary of 250,000 words, and a man of 1900 would have found considerable difficulty in reading an ordinary newspaper. On the other hand, the men of the time could still appreciate the older English literature . . . Certain minor acts of uniformity accompanied this larger one. The idea of a common understanding and a general simplification of intercourse, once it was accepted, led very naturally to the universal establishment of the metric system of weights and measures, and to the disappearance of the various makeshift calendars that had hitherto confused chronology. The year was divided into thirteen months of four weeks each, and New Year's Day and Leap Year's Day were made holidays, and did not count at all in the ordinary week. So the weeks and the months were brought into correspondence. And moreover, as the king put it to Firmin, it was decided to 'nail down Easter.' . . . In these matters, as in so many matters, the new civilisation came as a simplification of ancient complications; the history of the calendar throughout the world is a history of inadequate adjustments, of attempts to fix seed-time and harvest that go back into the very beginning of human society; and this final rectification had a symbolic value quite beyond its practical convenience. But the Council would have no rash nor harsh innovations; no strange names for the months, and no alteration in the numbering of the years.

"The world had already been put upon one universal money basis. For some months after the accession of the Council the world's affairs had been carried on without any sound currency at all. Over great regions money was still in use, but with the most extravagant variations in price and the most disconcerting fluctuations of public confidence. The ancient rarity of gold upon which the entire system rested was gone. Gold was now a waste product in the release of atomic energy, and it was plain that no metal could be the basis of the monetary system again. Henceforth all coins must be token coins. Yet the whole world was accustomed to metallic money, and a vast proportion of existing human relationships had grown up upon a cash basis, and were almost inconceivable without that convenient liquidating factor. It seemed absolutely necessary to the life of the social organisation to have some sort of currency, and the Council therefore had to discover

some real value upon which to rest it. Various such apparently stable values as land and work were considered. Ultimately the Government, which was now in possession of most of the supplies of energy-releasing material, fixed a certain number of units of energy as the value of a gold sovereign, declared a sovereign to be the exact equivalent of twenty marks, twenty-five francs, five dollars, and so forth with the other current units of the world, and undertook, under various qualifications and conditions, to deliver energy upon demand as payment for every sovereign presented. On the whole this worked satisfactorily. They saved the face of the pound sterling. Coin was rehabilitated, and, after the phase of price fluctuations, began to settle down to definite equivalents with the names and everyday values familiar to the common run of people."

Whether we agree or not with all Mr. Wells's predictions, we can make quite sure that the world-use of the English tongue will bring results of vast importance to industry and commerce. It will mean the pooling of the brains of the world, the cheap and universal distribution of the best thought, the most expert processes. It will eliminate the time, energy, accommodation and material now used up in the waste work of translation. It will speed up business transactions, and minimise the risks of misunderstandings. It will seriously affect all the labour involved in the direct and accessory arts and crafts of book production. It will revolutionise the art and scope of advertising. It will make easy the employment of alien direction or alien craftsmanship where special needs call for it. It will modify business manners and customs, and change the whole character of commercial education.

Many of these changes are still "the music of the future," and we may safely desert their contemplation for the moment for the more immediate study of the intimate relationship which exists between international intellectual sympathy and international industry and commerce. I was much struck during my mission to Norway last spring by the fact that while the vast majority of the people sympathised with the Allies, the greater number of the academicians and "intellectuals" did not share this partiality. The Germans have never made the mistake of turning the cold shoulder to foreign scholars and students who have desired to share their educational advantages. On the contrary, they have welcomed them with open arms, confident that they would return to their own countries convinced that Germany was the repository of all that was best in scholarship, art, science, and industry. The folly of our over-modesty in this direction is plainly put in the Memorandum on Educational Propaganda in Russia to which I have before referred. I quote the following:—

"At the present time the only Readers for Russians who desire to learn English are the German publications of the firm of Mannstein in Riga. Apart from the fact that it is not to the advantage of British interests that the English language should be taught through the medium of German text-books, these editions are now unobtainable. There is, therefore, a demand for a carefully and attractively edited series of graduated Readers with English-Russian vocabulary and Russian notes.

"The demand for information on British universities opens up another series of very important publications. A book on the provision made for technical education in England is badly needed; and in order to convince the more sceptical, who have been taught to look on German methods as the *ne plus ultra* of the student's aspirations, it is highly advisable that such a work should be more detailed and elaborate than the scope of the series might seem to render necessary; for it must be remembered that Russian technical students know nothing whatever about technical study in England, which their ignorance inclines them to regard with contempt, while they are none the less attracted by detailed descriptions supplemented by suitable illustrations and diagrams.

"The libraries of the Russian technical institutes are not provided with representative English sections. It is therefore important, as a valuable form of propaganda, that a complete and representative section of British technical books should be presented to the leading Russian institutes as soon as conditions make this possible, and that these institutes should be supplied with the latest British publications which are regarded by British experts in the various subjects as being representative contributions of British scholarship to the knowledge of the particular branch of technical science.

"In considering the technical training of Russians, it is very important that a supply of machinery should follow as early as possible after British propaganda as to our technical resources. The British Consul at Baku stated in a letter to me that wherever a new technical school was to be opened in any town of Russia, German commercial travellers invariably appeared and took orders for the supply of technical equipment within six months. The Consul further remarked that technical workers who have become accustomed to given machinery in their student days later retained a fixed preference for this kind of machinery. The supply of British machinery to Russian technical institutes therefore becomes of capital importance."

May I here venture to say that so long as foreign book-shops display only the comparatively worthless products of our press, so long as English publishers pursue their short-sighted

policy of producing only books that are "popular," so long as Mr. Wells's bitter strictures on the production of books in English hold good—and they still do—so long will the best products of British brains remain little known abroad, to the immense disadvantage of all concerned. In this connection let me draw attention to an article by Professor Biagi in the "Vita Britannica," in which he tells us that in the year 1918 the total importation of English books and newspapers into Italy amounted to less than 70 tons, valued at about £14,000, while the importation of German books and publications was over 360 tons, valued at about £70,000, "and this latter," he says, "was not mere merchandise to be weighed in tons and hundredweights. It was rather so much poison-gas, that, little by little, saturated with Germanism places where it was received as an illuminant; it intoxicated men's minds and poisoned their consciences. Of all imports it was the most dangerous and deleterious, and we have found everywhere in Italy its evil effects."

Another reform which must be carried through if we are to make easy the world-use of English is a simplification of our wretched orthography. It is a most serious hindrance to the foreigner, and is, indeed, the one valid criticism that can be brought against the choice of English as the international speech. Into this highly controversial field I may not now enter. I can only emphasise the urgent necessity for some swift and practical solution of the problem.

I conclude this very inadequate treatment of a great subject with a sincere appeal to the enlightened patriotism of the English-speaking world.

We have hitherto strangely neglected our duty to our tongue. We have looked on indifferently when other nations, with a keener perception of national advantage, have energetically encouraged and supported the foreign study of their mother tongues. "L'Alliance Française" has been long at work, and a Portuguese journal, *A Lucta*, examining, in 1917, the influence of Germany's policy of endowing German schools abroad, saw in it one of the main causes of German success. Italian authorities and business corporations are making every effort to extend the study of their tongue here and elsewhere, and many of the newly-formed Anglo-Foreign Societies are energetically pursuing similar aims.

Provided it is done in no spirit of national aggression, this is all to the general good. No nation can be thoroughly understood except through the medium of its own speech. You cannot translate the soul of a people. Every student of a foreign language is adding a stone to the temple of international understanding. It is the imperative duty of every nation to contribute its share to the great synthesis of a unified humanity.

The great English-speaking democracies must not shirk their obligations to the world. The English language is more widely spoken than any other. More than half the newspapers, magazines and books of the world are printed in the English tongue. Long ago, the great German philologist, Grimm, declared that "the English language, as used by Shakespeare, can rightfully be called a world-language, and seems, like the English people itself, destined in the future in yet greater measure than heretofore to rule in all the ends of the earth. When we consider its richness, intellectuality and condensed adaptability, no one of all the other living languages may be placed at its side; yea, not even our own German language, which is torn even as we are torn."

It is not our business to thrust our language upon other nations. Aggressiveness always defeats its own ends. But we ought not to stand indifferently aloof when foreign students need our friendly help in their endeavours to win the key to the life and thought of the English-speaking world.

In the far-distant future, when empires have lost their meaning and the names of nations have become mere geographical expressions, the world-wide use of the English tongue will remain the noblest and the most enduring monument to the energy and genius of our race.

DISCUSSION.

Miss A. Deane Butcher, in opening the discussion, said the Hon. J. Cody, Minister of Education in Canada, had given her his card in order that she might speak in his name. Mr. Cody had written: "Why did not England trade with the French Canadians?" French Canadians could not speak or understand a single word of the English language. In order to overcome that difficulty, why did not English people send out their trade circulars properly printed? At the present time English circulars that were sent out were printed with thirteen vowel sounds and in 104 different illogical and silly ways. The Canadian Minister of Education had therefore adopted what was called the Orthotype notation, which was merely a proper print which everybody could

understand and which took only five minutes to learn. There were forty different nationalities in Toronto, and the Orthotype notation was used for the teaching of the Chinese in that city, for the purpose of carrying out the experiment in a small way. At a recent meeting of the Society, Professor Armstrong suggested that a very drastic remedy should be applied to English headmasters, namely that they should be crucified. As a matter of fact the headmaster was not the culprit; he was simply the victim of a very bad system of education under which three years were spent in the elementary education stage in teaching printers' errors. After being taught, the children could not understand their own language; they could not pronounce a single word, and they could not explain to a foreigner the meaning of English print. The real criminal was not the headmaster but the printer. The printer had made no progress in a hundred years, and printed exactly as he did a hundred years ago. In a progressive world every book that was printed ought to be better printed than its predecessor. She had spent eleven years on the Continent studying the question from the commercial point of view, and she was able to echo Mr. Gladstone's statement that the English printer made this nation a laughing-stock on the Continent. Providence had arranged that English ideals should go all over the world in English speech and in English writing. The English language was not an art, but the English print was; it was a graphic art of expression; but nevertheless there was a whole army of printers who had forced upon the nation an iniquitous and pernicious print for over a hundred years. The printer said it was not his fault, but that it was due to the type-founder, who made him buy founts of type which he was obliged to use. It was a disgrace that the nation should be absolutely under the thumb of the type-founders, some of whom could not even read. If an absolutely false notation was used, illogical children must as a consequence be brought up, and it was absolutely impossible that English trade should go all over the world. Every business man knew perfectly well that what he sold abroad depended on the character of the circular he sent out. During the eleven years that she was in France, Italy and Germany studying the question she did not find a single man, from the Chamberlain of the Pope down to a Paris coachman, who did not want to learn the English language, because they thought they were going to make money thereby. They all wanted to learn the English language, and why should the English printer prevent them? Dr. Cody also said that the Germans from Chicago held the whole of the trade with the French Canadians simply because English printers would not send a sensible circular to them. She suggested that every patent medicine, every piece of soap, every piece of machinery, should be wrapped up in intelligible English print, and that the trader should thereby circulate the English language.

Mr. J. Munford said that as a wicked headmaster he desired to make a few remarks on the interesting paper which had been read. It was probably of greater importance than any other speech delivered in London that day, or which had been delivered in London for many a long day. The spread of the English language meant the development of English manufactures and industries, and the safety and security of the Empire. For the past fifty years he had advocated the use of phonetic spelling, and he was at the present time a member of the Committee of the Simplified Spelling Society. The great difficulty in teaching the English language was its diabolical spelling. The late Archbishop of Canterbury, Dr. Temple, who had been headmaster of Rugby, one of the greatest authorities on education who had ever lived, told him that if he had his way he would spell judge "juj," and that if phonetic spelling was adopted in this country as, for instance, in Italy, one whole year would be saved in the educational life of every child. If a school-child who was preparing his work for the following day was asked what he was doing he always gave the same answer: "Spelling and Tables." Personally, if he had his way he would throw the spelling-book into the fire and put the table-book on the top of it.

Mr. Montagu C. Butler said he was certain that most of those present felt inclined to say "Hear, hear" to almost everything the reader of the paper had said, but personally he differed very strongly from him in the remarks he had made in regard to Esperanto. He was one of the misguided fanatics who very strongly believed in Esperanto as perhaps the greatest means of bringing the nations together. He was convinced that in perhaps five hundred or a thousand years—possibly very much earlier—there would be a universal language, and although it was difficult to prophesy he believed that it would be either English or Esperanto. At any rate, he asked that Esperanto should not be dismissed as a mere fad without every consideration being given to what could be said in favour of it. He urged that the study of Esperanto should be looked into, not in opposition to the English language, but as an aid to the English language and to world friendship in many ways.

Captain Harold Goad said that recently, after his return to Constantinople, he had looked a little more deeply than he had hitherto done into the subject under discussion, and found that the prospects for the foundation of an institute either in Constantinople or in Salonica were far greater than he had previously imagined. Everybody assured him that in two years such an institute would be practically self-supporting; all that was required was that a capable organiser should be sent out and guaranteed for two or three years a certain amount of money which would enable him to start and go forward. In Constantinople there

was a need for a central school or an institute, not only for the education of young Turks or young Armenians, who would subsequently go and teach in the Armenian and Greek schools which had been established throughout the Turkish Empire through the charity of the Armenians and Greeks, but also for British subjects in Turkey. The Government had appointed a strong committee to look into the whole question and advise what should be done, and he thought the time had arrived when those concerned should push for all they were worth in order to obtain something that would be permanent and definite. If some conception could be formed on the part of those interested as to what was really the best method of procedure in order to spread the education in English that was so fervently desired, he thought it would be obtained much more easily at the present time than had been the case in the past or would be the case in the future. The Government had now come up to the sticking-point, and every endeavour must be made not to allow them to turn back. The necessity of something being done had been urged by many of the Balkan peoples. Quite recently the Serbian Government had asked for not less than three hundred English elementary school teachers to be sent to Serbia to teach in the schools. He believed that offer was declined, for the reason that to send out such a large number of teachers without some sort of direction would probably defeat its own object, because many of the teachers might go out without much knowledge of the condition of affairs they were likely to encounter, and might as a result return after a very short time to this country, thus bringing discredit upon themselves and throwing a wet blanket over the enthusiasm displayed by the Serbian Government in the project. It was thought it would be better to adopt a system similar to that initiated in Florence, namely, to establish a school at which teachers of the country could learn the language sufficiently well to take diplomas for teaching in the public schools, and that he hoped would be done. He was not at one with the author in his suggestion that travelling teachers would accomplish the object in view more economically and with greater effect than an institute of an expensive nature. On the other hand, if the Government decided to take action in the matter and to spend a certain amount of money, it might be possible to carry through a more ambitious project, *i.e.* they might be induced to start in the principal capitals of Europe an English school for teachers who would go out to teach in the elementary or secondary schools of the country, and in that way the effect would be spread more rapidly than would otherwise be the case. In Constantinople alone the French had six hundred schools in which the teaching of French was compulsory; these were controlled by the French Government through the "Alliance Française," the schools being paid so much annually on condition that French was a compulsory subject. This country could not hope to go as far as that, but it could at least make it possible for the Serbian, the Bulgarian, and the Greek Governments to find material at hand for teaching English in all their schools, and in a very short while the scheme would probably become self-supporting. That, he thought, would be the best solution of the whole matter, because such a possibility would probably induce the Foreign Office to take a bold and strong line.

THE CHAIRMAN (Sir Edward W. Brabrook, C.B.), in moving a hearty vote of thanks to the author for his paper, said he did not know whether it could be truthfully said that the prevailing characteristic of the English was modesty, shyness and want of self-assertion, but it seemed to be something of that kind after hearing what the author had said as to the manner in which other countries were preparing to promote the knowledge of their own languages and the little which had been done by this country. He was very glad to think that, of that little, a very large proportion had been done by the personal exertions of the author. Mr. Hayes was still actively engaged in the promotion of that work, and he was quite certain the paper he had read would have a great weight in rousing public interest in the movement of which he was the prominent head.

The resolution of thanks was then put and carried unanimously.

MR. ALFRED E. HAYES, after thanking those present for the hearty manner in which the vote of thanks had been passed, said he naturally felt very strongly on a subject to which he had given the greater part of his so-called leisure for over sixteen years, and he was very glad indeed to hear from Captain Goad that there was now some prospect of the British Government lending a helping hand. He was delighted to hear what Captain Goad had said in regard to the prospect of the Institute in the Balkan States becoming self-supporting, although, personally, he was not in favour of a great deal of money being spent by English people in teaching their language abroad, whatever the French might do. He was convinced that there were means and methods by which it would be possible to develop the active demands in foreign countries for the teaching of English in a native and indigenous manner and at once to build up self-supporting institutions, perhaps of a simpler, but of a very effective nature, which would naturally grow year by year.

The meeting then terminated.

WILD SILK INDUSTRY IN SOUTH-EASTERN MANCHURIA.

The most interesting and important industries in the city of Antung, and perhaps throughout the whole of the district, are those connected with the various processes employed in the production of the so-called "wild silk." This silk, which in

its reeled form is known commercially as "tussah," and when woven, as "pongee," has steadily grown in popularity both in the Far East and in America and Europe, and, thanks to successful experiments in dyeing, is destined in the future to be in even greater demand. Its tensile strength and beautiful natural golden brown colour are chiefly responsible for its popularity.

The silkworm is known to the Chinese as the shan tsan or mountain silkworm, and scientifically has been variously classified by different authorities. Among the classifications given are Antherea pernyi, Bombyx pernyi, and Bombyx fertoni. Both in size and general appearance it is quite different from the silkworm which produces the better known white silk. On maturity it varies in length from three to five inches, and is of a soft green colour, with tufts of reddish-brown hairs at different parts of its body.

While the white silkworm must have the leaves of cultivated mulberry trees for its food, its less particular and more hardy northern cousin subsists on the leaves of several species of dwarf mountain oak which are native to eastern Manchuria, and grow uncultivated in great abundance on the sides of the otherwise rather unproductive hills that traverse this entire district. These trees serve the purposes of sericulture best when at a height of from five to six feet, and are accordingly kept from growing too tall by prunings made at intervals of several years. Where the natural groves are insufficient, recourse is had to artificial planting from seed. This, however, is a slow process, since from four to seven years' growth is required to produce a tree useful for feeding, and the trees are not at their best until they are from twelve to sixteen years old.

The cocoons used for propagation purposes are naturally selected from crops which have shown special quality. When it is about time for the butterflies to emerge the cocoons are strung on cords and suspended in a quiet room. The opening through which egress is made is created by means of a secretion that dissolves the fibres at one end of the cocoon. After their emergence the males and females are allowed to remain together for but one day, after which the former are released to fly where they will. The females are then taken to the place where it is desired that they should lay their eggs. In the spring this is in a basket filled with straw or twigs, and in the autumn, when the crop of leaves is ready for eating, direct to the oak trees. Each female lays an average of 150 eggs and is then released to spend the short remainder of her life where she sees fit. A period of from one to two weeks is required for the eggs to hatch. When there are indications that the spring crop of leaves will be late, hatching is retarded by means of exposing the eggs to the cold.

From the time of hatching to the commencement of the spinning of the cocoons a period of from forty to forty-five days elapses, during which the larva passes through five feeding and four sleeping phases, each transition being marked by the changing of the skin and an increase in size. The average time required for the spinning of the cocoon is from three to eight days.

According to a report by the United States Consul at Antung, the great fluctuations in the annual crops are occasioned principally by the many dangers to which the silkworm is exposed during the larva stage. The depredations of birds, stinging insects, and even of the ant, work great havoc at this time and require the most constant attendance if they are to be prevented. Fortunately, this is work that women and children can accomplish, thus releasing the men for the more arduous farm labour.

Two crops of cocoons, one in the spring and another in the autumn, are produced annually. The spring crop, which is put on the market early in July, is the smaller of the two and is used principally to produce eggs for the autumn crop, which is usually marketed after the middle of October. Cocoons are packed by the farmer in large woven willow baskets containing about 30,000. A basket freshly packed weighs approximately 400 lb. The weight, however, is reduced to about 270 lb. by the following spring owing to the shrivelling up of the chrysalides during the dry winter season.

The cocoons are transported to Antung, where they are stored in large walled or fenced enclosures and in warehouses until sold. Cocoons and spun silk are sold through large firms in Antung, who, through their familiarity with both the yearly production and with the market demands, are enabled to act as brokers, and to collect a commission for their services from both the seller and the producer. The purchasers, apart from the local filature owners, are chiefly representatives of filatures in Chefoo, Shanghai and Japan, who go to Antung as soon as the season opens to secure their stocks.

While the production of wild cocoons is a common industry throughout the entire district, the main centres are situated in the south, with Kaiping (in Mukden district) in the west and Antung in the east as the most important. In both of these cities many filatures (factories in which the thread is reeled off from the cocoons) are situated.

Cocoons which are intended for reeling during the winter months may be stored in baskets with sufficient covering to keep out rain and snow. Those, however, which it is intended to carry over to the following summer before using must have the chrysalides killed before spring, as otherwise when the weather becomes sufficiently warm the butterflies will develop and pierce the cocoons, thus partially spoiling them. The usual method of killing the chrysalides is by storing the cocoons in large warehouses capable of being heated, and in the midst of the extreme cold season raising the temperature to that of a spring day for a period of several days, after which it is lowered to that obtaining out of doors. When this process has been repeated several times all the chrysalides may

safely be assumed to be dead and the cocoons carried over to summer with no danger of being pierced.

Cocoons are prepared for reeling by a process of steaming which serves to dissolve the secretion with which the component fibres have been fastened together. This process also kills the chrysalides in the case of the cocoons which have not been treated by the process just described. Steaming is done in large iron cauldrons sunk into brick stoves, which are usually placed in a room immediately adjoining that in which the reeling is to take place. The cauldron is first filled with a solution made by dissolving in water approximately six to eight ounces of soda for each thousand cocoons to be steamed, and after this mixture has been heated to the boiling point the cocoons are thrown in and rapidly stirred for several minutes. They are then dipped out and put into a round container not unlike a deep sieve in appearance, but with parallel strips of bamboo for a bottom, which is placed immediately over the cauldron so that the bamboo slats are only an inch or more above the surface of the boiling solution, and in this position are steamed for several hours.

When the process of steaming has been completed the inextricable mass of tangled fibres which form the outer covering of the cocoons, and which is known as ta-wan-shu, or "big waste," is removed; the innermost fibres which actually enwrap the chrysalides are hopelessly tangled, and are known as the erh-wan-shu, or "second waste." From its nature waste cannot be reeled, as is the thread, but must be chopped up, combed, carded and spun. Hitherto the waste has always been shipped to Europe for manufacture.

After the outer waste has been removed the cocoons are taken into the reeling room and distributed to the reel operators, who are usually arranged on high platforms running the length of a long narrow room, one operator to a reel. Each operator then gathers the ends of the fibres of from six to eight cocoons, twists them into a thread which he fastens to his reel, and by means of a treadle starts the reel revolving. As the thread passes through several rings before reaching the reel it is twisted, and is wound on to the reel in the form of the finished thread. The reels are of two sizes, one with a diameter of 1½ ft. and the other 2½ ft., and in Antung are all operated by foot power.

The average capacity of an operator is from 700 to 900 cocoons a day, while the experts attain occasionally to 1200. The skeins, which are usually some 4 ft. in circumference, are folded once and twisted spirally. The thread, when it has been manufactured into skeins in this manner, is known as "tussah."

The silk-producing qualities of the spring and autumn cocoons are different. One thousand spring cocoons will furnish from 5½ oz. to 8 oz. of tussah, whereas the autumn cocoons yield from 8 oz. to 12 oz. The silk produced from the spring cocoons is of a softer and more pleasing texture than that from the later ones.

Tussah is classified by the Chinese trade into five grades, known as "extra," "No. 1," "No. 2." "No. 3," and "No. 4," according to quality. It is also divided into two general classes, "not filature" and "filature." The term "not filature" is applied to that reeled on a small scale in many different localities, and which as a result lacks uniformity, while "filature" is used to describe the product of the larger factories, which maintain standards of approximate uniformity.

Waste is commercially divided into two classes—No. 1 and No. 2—which correspond generally to the "big waste" and "second waste" already described. It is usually put up into bales of from two to three piculs (266⅔ lb. to 400 lb.)

The silk filature industry in Antung city is only twelve years old. In the year 1907 two small filatures were started, one under the auspices of the local Chinese officials, and employing 120 hands, and the other a small Japanese enterprise employing Chinese labour. The number of reels in one of the larger filatures ranges from 300 to 1200, and in the smaller ones from 25 to 100. In addition to these regular filatures a considerable amount of reeling is also done in private houses and as a sideline in other places of business.

Hitherto Chefoo has been the centre of both the reeling and weaving of wild silk, but in recent years the owners of filatures have steadily been moving their establishments to Antung. The change is a natural one, as it is cheaper to reel off the silk at the source of supply, and thus remove from the cost of production the items of transportation of cocoons and of duties levied by the Chinese customs. To this has now been added the further plan of moving the pongee weaving industry from Chefoo to Antung. In order to ensure success and to eliminate wasteful competition it is proposed that a single large weaving mill be established, the capital of which is to be contributed by the owners of the filatures.

A Japanese company, known as the Anto Yoko Manshu Kemmo Boseki Koba, has constructed a large factory in which it is proposed to spin silk "waste" into thread, and with this to weave various fabrics for the American and Japanese markets. The machines are to be of a variety especially suited for the purpose and are to be worked by electricity.

When the proposed large pongee weaving mill and the factory for the manufacture of the "waste" are put into operation, Antung will not only be the centre of cocoon production and "tussah" reeling, but of the final process of manufacture as well. As, comparatively speaking, only a small portion of the land in the Antung district suitable for growing scrub-oak is now so used, and since with the ever-increasing Chinese population there will be no possibility of a shortage of the necessary labour, the dimensions to which the industry can attain are limited solely by the world demand for tussah and pongee.

HORSE-BREEDING IN BRAZIL.

The following is a translation, by the United States Vice-Consul at Rio de Janeiro, of an interesting account of horse-breeding in Brazil prepared by the Brazilian Foreign Office :—

In Brazil vast areas are available for horse-breeding. The horses of this country are derived from different races, which, by crossing with pure-bred English, Norman, and French stock, have developed a distinct national type. Small, light, and intelligent, the Brazilian horse is useful for military purposes and is excellent for the saddle, answering readily to the demands of the rider, and enduring long journeys without food.

Federal and State Governments alike have taken the initiative in the selection and crossing with pure British breeds, and haras or official studs have been started in several States.

The Brazilian stud counted 6,065,730 head in 1916, distributed as follows :—

Alagoas	96,590	Parana	217,090
Amazonas	8,740	Pernambuco	211,980
Bahia	809,940	Piauhy	164,690
Ceará	218,300	Rio do Janeiro	142,890
Federal District	5,600	Rio Grande do Norte	95,680
Espirito Santo	78,590	Rio Grande do Sul	1,056,110
Goyaz	265,830	Santa Catherina	140,070
Maranhão	148,590	São Paulo	497,970
Matto Grosso	140,490	Sergipe	96,040
Minas Geraes	1,505,600	Acre Territory	530
Pará	57,650		
Parahyba	106,760		

The war has played havoc with horses in many countries, and, according to the following estimates, Brazil should be in a position now to make good part of these losses. World's figures are as follows: Russia in Europe, 23,860,178; United States, 21,123,000; Argentina, 9,427,000; Russia in Asia, 6,577,693; Brazil, 6,065,730; Austria-Hungary, 4,370,884; Germany, 3,341,627; Canada, 2,990,635; Australia, 2,521,983; France, 2,317,205; India, 1,818,873; United Kingdom, 1,699,640; Japan, 1,533,829; Italy, 955,878; Union of South Africa, 714,414; Sweden, 599,136; Cuba, 560,580; Uruguay, 556,307; Chile, 553,869; Spain, 525,853; Denmark, 515,415; Bulgaria, 477,233; New Zealand, 404,284; Holland, 384,445; Belgium, 317,080; Algeria, 221,178; Switzerland, 186,513; Serbia, 152,136; Tunis, 88,000; Portugal, 87,765; Costa Rica, 52,095; Egypt, 47,911.

So far, exports of horses from Brazil are practically nil. In 1917 only one horse, valued at 900 milreis, was exported, but 353 were imported for breeding purposes in 1916, and 382 in 1917.

GENERAL NOTES.

Miss Eleanor Rowe.—Miss Eleanor Rowe, who died on January 3rd, was for some twenty years manager of the School of Art Wood-carving, South Kensington. The school was founded by the Royal Society of Arts in 1878. Its first quarters were in Somerset Street, Oxford Street, and after various changes it moved in 1908 to its own premises in Thurloe Place. Miss Rowe was a skilful craftswoman and a good organiser, and she also wrote several excellent text-books, including "Hints on Wood-carving," which ran through many editions; "Practical Wood-carving," which has now been republished in two volumes; and a series of reproductions, "Studies from the Museums" and "French Carvings from the Museums," with a preface giving a history of the periods covered by the French Renaissance. It was Miss Rowe's enterprise that opened the Schools of Architecture to women. As head of a large and growing craft school, she felt it necessary to obtain a thorough knowledge of fine art architecture, and finding that the National Art Training School at South Kensington (now the Royal College of Art) would not admit women to its architectural courses, she joined the course of Fine Art Architecture under the late Professor Roger Smith, at University College. He soon became aware of the excellence of his pupil, but he found that the rules of the College barred women from the architectural courses. He could see no reason for such a rule, and he therefore put the ease to her fellow-students, who were all men, and took their vote on the subject. The vote was unanimously in favour of granting her and all future women students the same privileges they themselves enjoyed, and opening all the examinations and awards to them. This led to an official decree endorsing their vote. Miss Rowe passed the final examination with high honours, and was followed the next year by two other women students from the School of Wood-carving, who also took the highest awards after the gold medal.

Oil-driven Ships.—Mr. J. H. Williams, at a meeting of the Institute of Marine Engineers at the Minories on January 27th, said that the Americans were a long way ahead of us in the use of oil fuel for ships. There was hardly an American ship coming over to-day that was not burning oil. As a rule, for shipping oil was a cheaper fuel than coal, and in many ports it was half the price of coal. In South America oil was displacing coal very rapidly.—"*Times*" *Trade Supplement.*

Cotton Shortage.—Presiding at the annual general meeting of the shareholders of the London, County, Westminster and Parr's Bank, Mr. Walter Leaf referred to the sudden and very serious increase in the cost of cotton, which was likely to hamper, in the very near future, the growth of our greatest textile industry. This increase was quite independent of any question of exchange; it was due to an alarming shortage of the raw material. The American crop had been materially curtailed by the ravages of an insect pest, which was, unfortunately, spreading till it threatened the complete destruction of the Sea

Island cotton. At the same time the United States were competing with us for the limited crop of Egyptian cotton, which was of the utmost importance to Lancashire, with the result that the price had been forced up from about 29*d.* at the beginning of October to no less than over 74*d.* to-day. The prospect was undoubtedly serious, and it was to be hoped that speedy effect would be given to the efforts which were being made to extend the growth of cotton within the Empire.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m. :—

February 18. — Sidney Preston, C.I.E., "English Canals and Inland Waterways." Neville Chamberlain, M.P., will preside.

February 25. — James Currie, C.M.G., Ministry of Labour (Training Department), late Principal, Gordon Memorial College, Khartoum, "Industrial Training."

March 3.—William James Garnett, First Secretary, H.B.M. Diplomatic Service, "Mongolia from the Commercial Point of View."

March 10.—H. M. Thornton, "Gas in relation to Industry and Housing." Sir Robert A. Hadfield, Bt., D.Sc., F.R.S., will preside.

March 17. — William Worby Beaumont, M.Inst.C.E., "Street Passenger Transport of London."

March 24.—Air-Commodore Edward Maitland, C.M.G., D.S.O., A.F.C., "The Commercial Future of Airships."

April 14.—Joseph Thorp, "The Fundamental Basis of Good Printing."

Indian Section.

Friday afternoon, at 4.30 p.m. :—

March 19.—Sir William S. Meyer, G.C.I.E., K.C.S.I., Financial Member of Council of the Governor-General of India, 1913-18, "The Indian Currency System and its Developments."

Thursday afternoons, at 4.30 p.m. :—

April 15.—Brigadier-General Lord Montagu of Beaulieu, C.S.I., "Roads and Transport in India."

May 20.—Sir George Cunningham Buchanan, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

Date to be hereafter announced :—

Sir Valentine Chirol, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

Colonial Section.

Tuesday afternoons, at 4.30 p.m. :—

March 2.—G. F. Scott Elliot, M.A., B.Sc., F.R.G.S., "Trade Routes for the Empire in Africa." Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., will preside.

May 4.—Professor William A. Bone, D.Sc., Ph.D., F.R.S., "Lignite."

Indian and Colonial Sections (Joint Meeting).

Date to be hereafter announced :—

Professor Sir John Cadman, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E., "The Oil Resources of the British Empire."

Dates to be hereafter announced :—

Charles H. Sherrill, "Stained Glass."

Graily Hewitt, "Rolls of Honour."

Charles Crowther, "The Arts and Crafts of Japan" (with examples from the author's private collection).

William Cramp, D.Sc., M.I.E.E., "Pneumatic Convoying Plants, with special reference to the Transport of Grain."

L. Gaster, "Industrial Lighting in its relation to Efficiency."

Cantor Lectures.

Monday evenings, at 8 p.m. :—

Charles Frederick Cross, B.Sc., F.R.S., F.C.S., "Recent Research in Cellulose Industry." Three Lectures.

Syllabus.

Lecture I.—February 16.—*Compound Celluloses.* (*a*) Lignocelluloses: (1) Jute: Heart damage of baled jute—Bearings on problems of constitution and formation, and on industries—Special treatment of jute and jute fabrics for decorative and "useful" applications; (2) Esparto: As a special type of lignification—New researches; (3) Woods: Lignification and de-lignification—Relations of lignone to their "aromatic" by-products. (*b*) Cutocelluloses, a special chemistry of raffia—The question of natural cellulose esters, and a technical ideal.

Lecture II. — February 23. — *The Cellulose Industries.* Cotton-spinning — Investigations of factors of process and qualities of products —Raw cotton and (normal) bleached cotton—Artificial silk, controlled hydration of celluloses by chemical process and a critical re-investigation of paper-making processes—Twisted paper yarns.

Lecture III.—March 1.—*Cellulose and Derivatives.* Nitrates—Acetates—Progress of research and industry—Specific volumes of cellulose and hydrates—Data of fundamental importance, scientific and industrial—The problems of constitution.

Walter Rosenhain, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

Arthur Thomas Bolton, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758-1837." Three Lectures.

May 3, 10, 17.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 16...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. C. F. Cross, "Recent Researches in the Cellulose Industry." (Lecture I.)

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Rev. A. H. Finn, "The Silences of Scripture."

British Academy, King's College, Strand, W.C., 5.30 p.m. Ven. Archdeacon Charles, "The Apocalypse." (Lecture III.)

Surveyors' Institution, 12, Great George-street, S.W., 8 p.m. Captain W. H. Tapp, "Survey on the Western Front."

Geographical Society, 135, New Bond-street, W., 8.30 p.m. H.E. the Spanish Ambassador, "The Spanish Zones in Morocco."

TUESDAY, FEBRUARY 17...Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.30 p.m. Dr. W. R. Ormondy, "Recent Patents on Mixed Fuels."

Statistical Society, 9, Adelphi-terrace, W.C., 5.15 p.m. Professor E. H. Starling, "Food Conditions in Germany during the War."

University of London, London Institution, Finsbury-circus, E.C., 5 p.m. Mr. A. D. Innes, "The Mogul Period of the History of India." (Lecture II.)

Royal Institution, Albemarle-street, W., 3 p.m. Professor E. Wilson, "Magnetic Susceptibility." (Lecture I.)

Roman Studies, Society for the Promotion of, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. N. H. Baynes, "The History of Rome in Teaching and Research."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. N. E. Luboshez, "Fancy Lighting in Portraiture."

Anthropological Institute, 50, Great Russell-street, W.C., 8.15 p.m. Mr. J. R. Moir, "On the Occurrence of Flint Implements of Man in the Glacial Chalky Boulder Clay of Suffolk."

WEDNESDAY, FEBRUARY 18...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. S. Preston, "English Canals and Inland Waterways."

Aeronautical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Squadron-Leader P. Bishop, "Aircraft Design in relation to Standardisation."

Meteorological Society, 70, Victoria-street, S.W., 5 p.m. 1. Captain C. J. P. Cave, "The Status of a Meteorological Office and its Relation to the State and to the Public." 2. Mr. W. H. Dines, "Atmospheric and Terrestrial Radiation." 3. Mr. D. Brunt, "Internal Friction in the Atmosphere."

Microscopical Society, 20, Hanover-square, W., 8 p.m. 1. Mrs. A. Arber, "Studies on the Binucleate Phase in the Plant-cell." 2. Mr. R. Beer and Mrs. A. Arber, "Multinucleate Cells: an Historical Study (1879-1919)." 3. Mr. S. C. Akehurst, "Exhibition of Professor Silverman's Illuminator for Opaque Objects."

United Service Institution, Whitehall, S.W., 3 p.m. Colonel A. H. W. Haywood, "The Campaign in the Cameroons."

Industrial League and Council, Central Hall, Westminster, S.W., 7.30 p.m. Mr. W. J. Grosart, "Evolution of Modern Method in Industry."

THURSDAY, FEBRUARY 19...ROYAL SOCIETY OF ARTS, 3 p.m. Conference on House Furnishings at the Ideal Home Exhibition, Olympia, W.

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W, 5 p.m. 1. Messrs. J. S. Huxley and D. F. Leney, "Specimens of Sexually Mature Axolotls metamorphosed into the Amblystoma Form by feeding with thyroid gland, and of Urodele Larvæ precociously metamorphosed by treatment with Iodine Solution." 2. Major H. C. Gunton, "Entomologico-Meteorological Records of Ecological Facts in Life of British Lepidoptera."

Chemical Society, Burlington House, W., 8 p.m. 1. Messsrs. S. B. Schryver and C. C. Wood, "A new method for the estimation of methyl alcohol." 2. Messrs. C. S. Gibson and W. J. Pope, "$\beta\beta'$-dichlorethyl sulphide." 3. Messrs. W. K. Slater and H. Stephen, "Some derivatives of fisetol." 4. Mr. M. F. Barker, "Calorific value and constitution." (Part I.) 5. Mr. J. B. Firth, "Surface tension of alcohol-water mixtures."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. H. Smith, "Illustrations of Ancient Greek and Roman Life in the British Museum." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m.

Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W. (Wireless Section), 6 p.m. Major C. E. Prince, "Wireless Telephony on Aeroplanes."

Auctioneers and Estate Agents' Institute, 34, Russell-square, W.C., 7 p.m. (Junior Members.) Mr. E. Woolf, "Some Probable Problems at the Coming Quinquennial Valuation."

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, W., 5.30 p.m.

FRIDAY, FEBRUARY 20...University of London, University College, Gower-street, W.C., 5 p.m. Dr. T. Borenius, "Mediæval Art." (Lecture VI.)

Royal Institution, Albemarle-street, W., 9 p.m. Dr. E. J. Russell, "British Crop Production."

Dyers and Colourists, Society of, Huddersfield. Mr. H. H. Hodgson, "Research—its place and function in an Educational System."

Manchester. Professor F. L. Pyman, "The Properties of the Glyoxaline Ring."

Concrete Institute, 296, Vauxhall-bridge-road, S.W., 6 p.m. Mr. H. K. Dyson, "Some Points in Reinforced Concrete Design."

Mechanical Engineers, Institution of, Storey's-gate, Westminster, S.W., 6 p.m. 1. Annual General Meeting. 2. Discussion on Mr. Bergstrom's paper, "Recent Advances in the Utilisation of Water Power."

SATURDAY, FEBRUARY 21...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Positive Rays." (Lecture I.)

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FRIDAY, FEBRUARY 20, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, FEBRUARY 23rd, at 8 p.m. (Cantor Lecture.) Mr. CHARLES FREDERICK CROSS, B.Sc., F.R.S., "Recent Research in Cellulose Industry." (Lecture II.)

WEDNESDAY, FEBRUARY 25th, at 4.30 p.m. (Ordinary Meeting.) JAMES CURRIE, C.M.G., Ministry of Labour (Training Department), late Principal, Gordon Memorial College, Khartoum, "Industrial Training." THE RIGHT HON. SIR ROBERT S. HORNE, K.B.E., K.C., M.P., Minister of Labour, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, February 16th, DR. M. O. FORSTER, F.R.S., in the chair, Mr. CHARLES FREDERICK CROSS, B.Sc., F.R.S., delivered the first lecture of his course on "Recent Research in Cellulose Industry."

The lectures will be published in the *Journal* during the summer recess.

TENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 18th, 1920; Mr. NEVILLE CHAMBERLAIN, M.P., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Brunyate, Sir James Bennett, K.C.S.I., C.I.E., London.
Dongarsingh, Ramsingh, London.
Hunt, J. H., Dayton, Ohio, U.S.A.
Hutchinson, Lieut.-Colonel Thomas Massie, D.S.O., O.B.E., British Troops in France.
Layton, Gordon Shakespeare, Bury St. Edmunds.
Mackley, Edward N., Gateshead-on-Tyne.
Needler, F., Hull.
Nelson, Amos, J.P., Thornton-in-Craven, near Skipton.
Parsons, Lieut. Percival A., A.I.F., London.
Peto, William, M.I.E.E., London.

The following candidates were balloted for and duly elected Fellows of the Society:—

Brougham, William Henry Charles, Wallington, Surrey.
Darby-Legge, Captain A. W., R.A.S.C., London.
Doyle, Trevor Mervyn, Sydney, New South Wales.
Early, James Vanner, Witney, Oxon.
Garforth, Sir William E., LL.D., M.Inst.C.E., Pontefract.
Gibson, Alfred Herbert, F.S.S., Harrogate.
Guthrie, Thomas Maule, J.P., Brechin.
Holmes, William, London.
Hoxie, William D., New York City, U.S.A.
Hughman, Ernest Montague, Calcutta, India.
Lovekin, Luther D., Philadelphia, Pa., U.S.A.
Macara, Sir Charles Wright, Bt., Manchester.
Nasmith, Frank, Manchester.
Nicoll, Allardyce, M.A., Horton-cum-Studley, Oxon.
Powell, A. Cecil, Weston-super-Mare.
Shafik Pasha, H. E. Mohamed, Minister of Agriculture, Cairo, Egypt.
Stanners, Robert Whitfield, B.Sc., M.A., Cambridge.
Unwin, Mrs. Jane Cobden, London.
West, Edgar Louis, B.A., Rocester, Staffordshire.
Willson, P. G., London.
Wright, Commander Nathaniel H., U.S. Navy, Washington, D.C., U.S.A.

A paper on "English Canals and Inland Waterways" was read by Mr. SIDNEY PRESTON, M.Inst.C.E., C.I.E., Vice-Chairman of the Canal Control Committee (Board of Trade).

The paper and discussion will be published in a subsequent number of the *Journal*.

CONFERENCE ON HOUSE FURNISHINGS.

THURSDAY, FEBRUARY 19th, 1920; The Right Hon. SIR AUCKLAND GEDDES, K.C.B., M.P., President of the Board of Trade, in the chair.

A conference on House Furnishings was held in connection with the Ideal Home Exhibition at Olympia.

A full report of the Conference will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, February 3rd, 1920; LIEUT.-COLONEL SIR DAVID PRAIN, C.M.G., C.I.E., LL.D., F.R.S., Director of the Royal Botanic Gardens, Kew, in the chair.

THE CHAIRMAN said that the author of the paper, Sir Francis Watts, was unfortunately not present to read his paper. When in England last he was induced to prepare it at the invitation of the Society, but it was not possible for him to complete it before he returned to Barbados.

The paper read was—

TROPICAL DEPARTMENTS OF AGRICULTURE, WITH SPECIAL REFERENCE TO THE WEST INDIES.

By SIR FRANCIS WATTS, K.C.M.G., D.Sc.,
Imperial Commissioner of Agriculture for the West Indies.

Tropical departments of agriculture have arisen by an interesting process of evolution, in which the West Indies have been concerned to no small extent.

The geographical discoveries of the fifteenth and sixteenth centuries led to great interest being taken in the various plants and products found in newly-discovered countries, while the desire to colonise these countries was accompanied by the natural tendency to cultivate many of the plants then found for the first time, or then first made familiar as the source of commodities which had for some time reached European countries through devious channels, such as the caravan routes of the East or trade routes through the Red Sea.

In addition to cultivating the plants found in different countries, much effort was expended on attempts to introduce desirable plants into some of the new-found countries, and in this way there arose such epoch-making introductions as that of the sugar-cane from the Eastern to the Western world, tobacco, maize, potatoes, and other products from the West to the East, together with such carefully-planned efforts as were involved in the introduction of the bread-fruit from the Pacific to the West Indies, and the mango from the East also to these islands. Mere enumeration of the work done in this way would occupy the whole time of an evening's discourse.

When making introductions of new plants into new countries it soon became obvious that success could only be attained if proper provision were made for their care, at least until such time as they were propagated in such numbers as to become well established and well diffused locally. In this way there arose botanic gardens in tropical countries, whose first care was to receive such plant introductions as had been already decided upon, but which in turn soon reacted on the outlook, for those in charge of these gardens occupied themselves with the constant inquiry as to what plants could be collected and introduced into their gardens, largely with a view to ascertaining what new plants were capable of being grown in the new surroundings, and also to ascertain whether some, or many, of these would be capable of being grown commercially for profit.

At the same time, posterity owes much to the mission gardens which the early missionaries established around their stations; these served both as active centres for the introduction, acclimatisation and distribution of new plants, and also as centres whence the knowledge of the best manner of treating these introductions was disseminated amongst those into whose hands the new plants fell.

Considerable activity was displayed in these matters in the West Indies. A botanic garden was established in St. Vincent as early as 1764 and maintained until about 1830, when a number of such plants as could be moved were transferred to the botanic gardens at Trinidad. It is interesting to note that in 1772 the Royal Society of Arts awarded a gold medal to Dr. Young, who was then in charge, in recognition of the flourishing state of the garden. This garden played an important part in connection with plant introduction into the West Indies, for Captain Bligh placed here some 300 bread-fruit plants which he had brought from Tahiti: nutmeg, cinnamon and clove trees were also introduced into this garden; and to this place, also, Lord Rodney sent some of the mango and cinnamon plants which he took from a French man-of-war in 1792.

A botanic garden was also established at Bath, in Jamaica, in 1774. Various plants were brought there from Tahiti by Captain Bligh, amongst which were four varieties of sugar-cane, as well as the bread-fruit and other plants. After many changes and vicissitudes in the history of these early gardens, botanic gardens, conducted on similar lines to those with which we are now familiar, were established in the West Indies, in Jamaica and Trinidad.

The closing years of the nineteenth century

were critical ones as regards the agriculture and commerce of the British West Indies; up to that time most of the islands had been dependent upon sugar as the mainstay of their agriculture and commerce; sugar was the dominant factor in most of them; it was so in the larger colonies, such as British Guiana, Trinidad and Jamaica, as well as in Barbados, Antigua and St. Kitts; while even those islands like Grenada, St. Vincent, St. Lucia, Montserrat and Nevis, where sugar cultivation is now relatively unimportant, then depended mainly upon that industry. The period about 1883 was critical for the West Indian sugar industry, as the price of sugar fell to a point at which its production was no longer remunerative. In some of the islands where the disadvantages were most marked, the sugar industry so declined that in a few years but little sugar was being produced in such islands as Grenada, St. Vincent, Montserrat and Nevis, in most of which other industries had been substituted, as cacao in Grenada, arrowroot in St. Vincent, and limes in Montserrat and Dominica. The sugar industry was, however, maintained in a struggling condition in the more favourably situated islands of Barbados and St. Kitts, while it appeared to be moribund in Antigua.

It is not necessary to enter at length on the causes of the decline of the British West Indian sugar industry; suffice it to say that the main reason was the competition of the beet-sugar industry of the continent of Europe, aided by the very unfair system of state bounties there in vogue, whereby the sugar producers of Germany and Austria, and, to a less extent, of France, received sums ranging from £1 or £2 per ton up to, at one time, as high as over £5 per ton, for the mere act of dumping sugar into Great Britain, and this at a time when the market price of West Indian raw muscovado sugar, the type then principally made, ranged from about £7 10s. to £9 per ton. Under the fiscal system then in vogue in the United Kingdom there was no measure of protection against this condition of affairs, and the sugar industry of the West Indies would have been extinguished but for the fact that the tariff conditions in the United States permitted the importation of British West Indian sugar at moderate rates of duty, while imposing upon sugars receiving foreign bounties additional rates of duty equivalent to the bounties.

This great decline in the value of sugar led to serious consideration of the economic prospects of the West Indian colonies; this took the form of an inquiry into the possibility of so improving the method of growing the canes and manufacturing the sugar as to enable the West Indian sugar industry to compete with the beet sugar produced in Europe. Adverse fiscal conditions, however, retarded the progress in this direction for many years, and led to investigations which will be referred to later.

In addition to attention being directed to the condition of the sugar industry, much thought was given to the possibility of introducing other industries which might tend to support some, at least, of the colonies, even were they not able entirely to take the place of sugar.

In 1885, Sir Joseph Hooker, commenting on the Report of the Royal (West Indian Finance) Commission, appointed in 1883, expressed the opinion that there could be no doubt that the future prosperity of the West Indies would be largely affected by the extension to other islands, unprovided with any kind of botanical establishment, of the operations so successfully pursued in Jamaica ("Kew Bulletin," 1887, Pt. 6, p. 6). This may be taken as the starting-point in a line of policy which has considerably affected the West Indies.

In 1884 Mr. (now Sir) Daniel Morris had submitted to the Colonial Secretary of Jamaica proposals for the formation in each of the smaller British West Indian colonies of small botanical establishments, which should be placed under the direction of some local officer, the provision of skilled scientific officers hardly being contemplated, and that they should serve as centres from which there could be distributed such plants as might be successfully introduced and have consideration as the basis of new industries.

The idea underlying the proposals was that the Botanical Department at Jamaica should serve as a central institution; that it should supply to the subsidiary stations such seeds and plants as were available which it was thought it might be desirable to introduce. It was contemplated that the central establishment would only communicate with the recognised officer in each colony thus associated, who would forward requisitions and transact all business as between the local and the central establishment. It was suggested that "the control of each station would be entirely in the hands of the local government; the connection with the central establishment would be confined to dealing with applications for seed, plants, or other purposes of a purely consultative character."

At the same time it was suggested by the then Assistant Director of Kew, Mr. (now Sir) W. T. Thiselton Dyer, that, in addition to distributing plants the central institution should organise a regular system of botanical bulletins containing practical hints as to the treatment of economic plants, and the conditions under which they might best be utilised in developing remunerative industries.

With a view to giving effect to these and cognate suggestions general proposals were addressed in February, 1885, to the Governors of the several West Indian colonies, including the Bahamas and British Honduras, strongly recommending the adoption of the scheme. In consequence of the transfer of Mr. Morris from the post of Director of the Botanical Department of Jamaica to that of Assistant Director of Kew, together with various other changes and obstacles to progress, some delay was experienced in putting the whole scheme into operation. A botanic garden was, however, established in Grenada in 1886, and about the same time a small appropriation was made by the Legislature of Barbados for the purpose of forming a botanic station in connection with the boys' reformatory at Dodds, where experiments with sugar-canes had already been started on a fairly extensive scale under the direction of Professor Harrison, with whom was associated Mr. J. R. Bovell. This was the first experiment station as such in the West Indies, and from it have originated many of the varieties of sugar-cane now most widely under cultivation. In the same year the botanic garden at St. Lucia was established, and in 1890 that of St. Vincent was revived.

In order to stimulate and aid the work thus initiated, Mr. Morris, the Assistant Director of Kew, was, at the request of the Secretary of State for the Colonies, entrusted with a mission to visit the several West Indian islands. An interesting account of this mission is recorded in the "Kew Bulletin" for 1891, pp. 103-168.

As the outcome of these efforts botanic stations, or gardens, were established in Antigua (1890), St. Kitts (1891), Dominica (1890), and Montserrat (1890), while a chemical laboratory, largely devoted to the consideration of agricultural problems, was established in Antigua in 1889.

This period marks a definite advance towards the development of scientific agriculture in the West Indies. The botanical establishments thus created were closely associated with Kew, which was largely responsible for the movement which led to their formation and for the ideas and principles on which their work was based. They were maintained by the several local governments with varying degrees of interest and financial support. These establishments marked the transition period from botanical establishments to experiment stations; they were useful in that they paved the way for later developments.

The general economic conditions of the West Indies became steadily worse in the years immediately following these efforts. The price of sugar declined steadily, and there seemed to be no prospect of its improvement. The production of sugar dominated West Indian affairs and as the prices of other commodities such as cacao, arrowroot, and lime juice also showed declining tendencies, there was great apprehension as to the future, the public finances of practically all the colonies being in a straitened condition. As a result of these conditions much difficulty was experienced in obtaining adequate appropriations for the botanical establishments.

This alarming state of affairs throughout the British West Indies led to the appointment, at the close of 1896, of the West Indian Royal Commission to inquire into the conditions and prospects of the sugar-growing West Indian Colonies. The Commission visited practically all these colonies in 1897 and reported in the same year.

The report distinctly marks a period in West Indian history, and should be freely consulted by all who desire to form a sound opinion on the state of West Indian affairs at that time.

The Commission clearly recognised that the colonies in question were dependent upon agriculture and must remain so dependent; the sugar industry they saw was dominant, though they feared it would be moribund unless drastic steps could be taken to save it. This industry seemed to be almost the only one suited to the conditions of many of the islands, but it was felt that something definite should be done to ascertain whether other agricultural industries might not be encouraged and developed to such an extent that they might become the mainstay of those colonies in which sugar cultivation gave least promise of being successfully revived. In this the colonies were confronted by lack of information and by lack of means to secure and apply such information as might be available.

As the outcome of this investigation and report definite recommendations were made for

the creation of an Imperial Department of Agriculture, to be supported entirely from Imperial funds. These proposals received the whole-hearted support of Mr. Joseph Chamberlain, then Secretary of State for the Colonies.

Time does not permit of anything but the briefest statement concerning the constitution and work of this Department, but an appreciation of the manner in which it originated, how it was supported, and what it has done, is essential to an understanding of the present position of agricultural departments in the West Indies, and possibly those of several other tropical possessions of the Empire.

The Imperial Department was inaugurated in October, 1898, Mr. (now Sir) Daniel Morris being appointed Imperial Commissioner of Agriculture for the West Indies. In planning his work Sir Daniel Morris wisely built upon existing organisations; he found a good foundation ready to hand in the botanic gardens and kindred institutions which had been evolved, as already stated, largely as the result of efforts and recommendations with which he had been intimately concerned. These institutions had, however, been lamentably stunted and starved from lack of funds and from the limited outlook of the local legislatures and other authorities upon whom they depended for support.

An appropriation amounting to some £17,500 a year was made available from the Imperial Treasury, and the Imperial Commissioner established his headquarters in Barbados; he speedily got to work in inquiring into the capabilities of the agricultural organisations in all the colonies, cognisance being taken of the botanic gardens, the chemical laboratories, and all the existing institutions likely to have a bearing on agricultural development, not forgetting the schools of various grades. The work which all these agencies had been carrying on in the past was studied and plans made for continuing what was promising and useful, and for extensions in new directions. It is important to recognise this continuity of effort, for it justifies the line of activity taken by Kew and by the several Colonial Governments in the time prior to the creation of the Imperial Department, and demonstrates the value of continuity of policy when once the policy agreed upon is soundly chosen. The absence of continuity of policy in colonial government may be held to be responsible for slow development in many directions, and in this, as in many other respects, the Imperial Department may well claim to have demonstrated much that is useful in administration.

The work of the Imperial Department in the earlier years consisted in assisting the local governments to put their agricultural institutions into better order; for this purpose grants-in-aid were made to every West Indian government. In the larger colonies, including British Guiana, Jamaica, and Trinidad, the grants were supplementary to the expenditure of the local legislatures, and they served in no inconsiderable degree to stimulate the work of the agricultural organisations and to keep their work in line with that carried on in the smaller colonies where the imperial grant-in-aid entirely supported the various activities of the local departments of agriculture which were created or consolidated, as the outcome of the fostering care of the Imperial Department. It is important to recognise that this action had the effect of definite local departments of agriculture being formed out of the poorly equipped and somewhat indeterminate institutions which existed at that time in most of the islands, particularly in the smaller ones.

The money appropriated for this purpose was, in every case, treated as a grant-in-aid to the colony receiving it; it was expended on recommendations made by the Commissioner in consultation with the local executive, and duly voted by the several legislatures concerned as part of the approved expenditure of colonies.

This condition obtained until 1909—that is to say, for ten years—during which time the cost of maintaining the local departments of agriculture in the smaller colonies was borne entirely by the Imperial Government, while material assistance was given to those in the larger colonies.

At the expiration of this time, in view of the improved condition of the colonial finances, largely as the outcome of the agricultural development fostered by the work of the Imperial Department, progressive diminution of the Imperial grants to the colonies was decided upon, and it was agreed that these grants should be diminished year by year, until they ceased in 1912–13.

All this time financial provision was made from Imperial funds for the Imperial Commissioner of Agriculture, together with his staff at headquarters, and also for the cost of the maintenance of the office and laboratories at headquarters and for travelling expenses and for the issuing of various publications. This condition is maintained up to the present time.

I may, perhaps, here add that, as the result of my experience, I feel that this is a condition essential to success, and that any attempt to depart from it will be detrimental to the interests of the work as a whole.

In this manner the following amounts have been granted to the several colonies in the years between and including 1898–9 and 1912–13, when the grants-in-aid ceased :—

	£	s.	d.
British Guiana	3,852	14	0
Trinidad	3,563	9	4
Jamaica	2,265	1	0
Barbados	20,044	9	0
Grenada	6,359	19	11
St. Vincent	16,072	16	8
St. Lucia	12,731	17	8
Dominica	15,120	14	5
Montserrat	6,911	16	11
Antigua	10,329	19	1
St. Kitts-Nevis	12,341	8	5
Virgin Islands	6,692	6	4
Leeward Islands Federal	15,089	13	5
Total grants	131,376	6	2

These amounts are exclusive of the expenditure upon the central establishment.

The creation of the Imperial Department of Agriculture and its assistance in directing the affairs of the botanical establishments which had been evolved in the several colonies, had the important effect of causing these institutions to be regarded definitely as agricultural departments, and not merely as botanical institutions. The change of outlook is important, for it implies that the departments are now expected to have regard to all that pertains to agriculture in the respective colonies; the work is expected to extend much beyond the introduction of new plants and the making of suggestions for their application in possible new industries; it is expected to take into consideration all this, together with the ability to advise concerning the cultivation of staple crops and the manufacture and manipulation of agricultural products, to have regard to general agricultural economics, and to give consideration to matters of education in so far as these have a bearing on the welfare of agricultural communities. This changed outlook affected the relationship between the agriculturists and the officers of the departments; there has resulted greater intimacy in their relations and more effective and continuous interchange of ideas and opinions, so that the work of the departments has influenced in a marked degree the agriculture of most of the colonies.

But beyond that there has been the important effect on the several governments, which now recognise more thoroughly than before that agricultural matters form an important, integral part of colonial administration, and that the maintenance of agricultural departments is as necessary as the maintenance of other departments, such, for example, as those concerned with public works or public health.

The work of the Imperial Department of Agriculture has thus two principal phases: it is concerned with the affairs of the larger colonies, British Guiana, Trinidad, and Jamaica, in so far as its availability for advice in a general capacity is concerned. The connection with the smaller colonies is more intimate, and the Department exercises a more detailed and general supervision in agricultural matters in these colonies. It is understood that each of the larger colonies is able to maintain a scientific staff, including such technical officers as chemists, entomologists, mycologists, botanists, and others, and is able to deal with its own scientific problems in detail. The case is different in the smaller colonies, for the cost of providing such fully-equipped staffs in each of these islands would create a disproportionate charge which the revenue would be unable to bear.

To meet these conditions, scientific officers are maintained on the staff of the Imperial Department of Agriculture. These officers are ordinarily resident in Barbados, but they travel as occasion demands. To them is entrusted the investigation of such matters as transcend the scope of the activities of the officers of the local departments. To a considerable extent these officers have been concerned in investigating the several plant pests and diseases which are of fundamental importance to agriculture in the tropics, and which cause serious losses and retard progress in the islands concerned, even to the extent, in some instances, of making it impossible to carry on the cultivation of certain crops unless the pests and diseases can be adequately and economically controlled. Reference will be made later to some of the main features of the lines of activity here outlined.

Agricultural activity was thus stimulated in all the West Indian colonies; the greater extent of the scientific work, the increased number of investigators, the interchange of ideas and opinions, produced their natural effect, so that increased scientific activity in relation to agriculture was soon observed in all the colonies, both large and small. The activities of the Imperial Depart-

ment thus reacted on the colonies of British Guiana, Trinidad and Jamaica, as well as on the smaller colonies.

As the Imperial Department is more intimately concerned with the details of development in the smaller colonies, it will be convenient now to centre attention more particularly upon some of the work done in these smaller islands, as exemplifying the results attained through the application of scientific principles to agricultural administration, using this expression in the broadest sense so as to include the functions of general government as well as the activities of the agricultural officers and the planters.

It is necessary to understand what are the salient industries of the different islands. To quote the Report of the West India Royal Commission of 1897, p. 3, "the prosperity of the West Indies in former times was mainly due to sugar and rum; the production of these commodities attained such dimensions as to dwarf, and at one time, almost to extinguish, every competing industry." Sugar production remains the principal industry of Barbados, Antigua, and St. Kitts, and constitutes an important item in St. Lucia. Up to quite recent times it was the main industry of Grenada, St. Vincent, Montserrat and Nevis, and was carried on in Dominica and the Virgin Islands. Of late the cultivation of cacao has succeeded that of sugar in Grenada, and to a smaller extent in St. Lucia and Dominica. The cultivation of limes is now the principal industry of Dominica, and one of considerable importance in Montserrat and St. Lucia. In St. Vincent the cultivation of arrowroot holds an important place, while quite recently, and largely as the outcome of the work of the Imperial Department of Agriculture, cotton has become the principal industry of St. Vincent, Montserrat and Nevis. Cotton is also important in St. Kitts, and to a lesser extent in Antigua and Barbados, while it has become of value to the peasant cultivators of the Virgin Islands.

With the establishment of the Imperial Department of Agriculture, and its financial assistance to maintain the local departments, a good deal of interest centred in sugar production. Experiment stations for the study of field problems had already been established in several of the islands; increased financial assistance was forthcoming for these, and their work was extended. Problems relating to the manuring and the cultivation of sugar-cane were investigated and some useful points elucidated; the work of producing new seedling sugar canes, which had been successfully carried on in Barbados for some years, was extended, new seedlings of promise were distributed to other islands, and on a smaller scale the work of producing new seedlings was undertaken in Antigua and St. Kitts. Here it should be stated that there was much activity on the part of the Agricultural Department of British Guiana in the production of new seedling canes and in the study of their characters, and also in investigating the manurial requirements of the sugar-cane and in studying certain soil problems, some of them of peculiar difficulty.

Much activity was centred in investigations concerning the pests and diseases of the sugar-cane; this aspect of the work was highly appreciated, for in the period about 1895–7 an outbreak of a virulent fungus disease, now known to be due to *Colletotrichum falcatum*, caused the almost complete extinction of the Bourbon cane, the variety then most extensively cultivated, and gave the gravest alarm to sugar-growers, who feared the total loss of their industry. Relief from the trouble was found in the fact that some of the varieties cultivated in the experiment stations—some of which had already passed into general cultivation—were found to be resistant to this disease, so that the danger was arrested by the general adoption of these resistant varieties. It will be readily understood that some time and effort were expended in ascertaining and demonstrating these facts, and that while this work was in progress grave anxiety prevailed amongst the growers of sugar. This position caused additional attention to be centred upon the production of new seedling sugar-canes, with a view to securing resistant canes with a maximum yield of sugar.

It may be claimed that the various pests and diseases of the sugar-cane, together with the means of controlling or mitigating them, are now fairly well understood. Some work still remains to be done in this direction, and this continues to engage the attention of the scientific officers.

As the outcome of all these efforts, the sugar-growers in the several islands are informed concerning the main principles involved in the cultivation and manuring of their canes and in controlling the pests and diseases to which they are exposed. They thus carry on their operations with a greater sense of security, a security which is felt to be all the safer from the knowledge that in their midst there is a body of men whose function it is to watch carefully for approaching danger and

devise means for fighting it. It is only right that attention should be drawn to the fact that in this and similar work many of the planters themselves have co-operated, and by their co-operation have hastened the progress of knowledge.

In addition to giving consideration to field work connected with sugar, the creation of the Imperial Department, with its financial assistance to the associated departments, made it possible to extend attention to factory problems. Up to the time of the creation of the department, the manufacture of sugar in all the smaller islands, including Barbados, was carried on in small factories making muscovado sugar; that is to say, the sugar was made by means of open pans heated directly over open fires, whereby a soft, brown sugar having relatively small crystals was made. An important and intrinsic defect of these small factories was that the mills used for crushing the canes were, as judged by modern standards, small and inefficient; they had but three rollers, and were capable of expressing only about 50 to 60 per cent. of juice from the canes, or even less in the case of very bad mills, such as existed in some of the islands; this would be equivalent to about 62 to 75 per cent. of the juice contained in canes of average quality. The quantity of cane required to make a ton of muscovado sugar was not accurately known, for the canes were seldom, if ever, weighed. Such estimates as have been made place the amount at some 13·5 to 14 tons of cane per ton of sugar under moderately favourable conditions, but in badly-equipped works the amount must have been greater. The actual amount would, of course, depend on the quality of the cane, which varies. In this connection it must not be forgotten that a certain amount of molasses was produced in conjunction with the muscovado sugar; the value of this varied, the product at times selling at good prices, at others being disposed of with difficulty. Still, on the whole, it was an important factor in the muscovado sugar industry.

For many years there had been much discussion with regard to adopting improved methods of sugar-making, for muscovado sugar was being disposed of with increasing difficulty; the refiners, who purchased by far the larger part of it were showing marked preference for the types of sugar produced in vacuum pans. Some attempts had been made to adopt modern methods in British Guiana and Trinidad, but in Barbados, Antigua, and St. Kitts this effort had gone little beyond the introduction of vacuum pans in a few cases; the mills still remained of the inefficient three-roller type. In spite of much discussion little progress was made.

The inadequacies of the muscovado system, and the necessity for the adoption of the methods of modern factories, were the subject of much consideration on the part of the agricultural departments in the Leeward Islands, particularly in Antigua, and at last the Antigua Sugar Factory Co. took advantage of a favourable opportunity that occurred and created a sugar factory on modern lines at Gunthorpes in that island. In order to secure the erection of this pioneer factory and to ensure that its results should be available for the guidance of others similarly situated, financial assistance was given by the Government to the extent of £15,000. The factory as originally put down was a very modest affair, but its work was conducted on strictly scientific lines, and the results, including the figures obtained in the factory and its laboratory, were regularly submitted to the Agricultural Department, which in turn rendered considerable assistance in the way of scrutiny and advice.

It was soon found that the general ideas with which the factory was planned were sound, but that much more had to be done in order to make it really efficient when judged from modern standpoints. Seeing that those who had embarked on the enterprise soon felt confidence in their venture, for it was under scientific supervision and its capabilities were becoming apparent, progress was steady and rapid. Time will not permit of anything like a detailed survey of the development of this factory; suffice it to say, that from the first crop of 1,634 tons manufactured in 1905, and 2,349 tons in 1906, the output of the factory had grown to 12,371 tons in 1916, the output for the succeeding years being somewhat smaller on account of drought and adverse growing seasons, which restricted the production of canes.

The progress of the factory can be measured from one or two salient figures; in the early days of the factory's working only some 65 per cent. of the sugar in the cane found its way to market in the form of commercial sugar, whereas in the later years this has reached 88 per cent.; refiners' crystals of 96° polarisation being made. This constitutes a gain in production of twenty-three on the hundred parts of sugar in the cane, but it is over 35 per cent. on the 65 per cent. recovery of the earlier years. At the same time

the quantity of cane taken to make a ton of sugar was reduced from about 9¾ tons to about 8¾ tons, a comparison which is, however, less accurate and of less importance on account of the varying nature of the quality of the canes. It should be added that a fourteen-roller mill was installed in the factory in 1911, and to this much of the improvement in recovery is due.

The Gunthorpes factory has thus served to demonstrate the possibilities of modern sugar-making in small places, and it has shown that a high degree of efficiency can be secured in what must, according to modern ideas, be regarded as quite a small factory. It may be well to state at this point that a factory of this size probably represents the limit of smallness for efficient working. The tendency is towards much larger factories, even to ten times the capacity of Gunthorpes.

It is worth noting in passing that this factory is based on co-operative principles under which the assistance of outside capitalists was invoked, and they entered into contracts with the owners of sugar plantations to supply canes on a profit-sharing basis for a period of fifteen years; at the expiration of this time, during which the debentures representing the principal portion of the capital of the venture were being repaid, the original contracting plantation owners received shares from the factory equal in number and value to the original capitalists' shares. It should be added that in the process of the expansion of the factory it was joined by other contractors who do not enjoy the same privilege.

The period of the fifteen years of the original contract has now expired, and the distribution of the shares to the original contracting proprietors will have been made by the time this paper has been read.

It is satisfactory to note that this contract, which included some features unfamiliar to previous West Indian experience, has worked without a single hitch, and that the factory was paying its way and demonstrating its economic soundness with the low prices of sugar that were realised prior to the war. The high prices obtained for sugar, as the result of the sugar shortage caused by the war, have added considerably to the profits, but the soundness of the principles on which the factory was founded and the relief which these were capable of affording to the sugar industry of the West Indies were demonstrated under pre-war conditions.

The influence of the Antigua sugar factory was not confined to that island, the information gained in its operation being widely disseminated and thoroughly discussed, as was the intention of the Government in giving it financial aid; in consequence of this the development of similar factories was considered in other islands. As the outcome, a well-equipped factory was established in St. Kitts, reaping its first crop in 1912. This factory is financed by the same group of capitalists as the Antigua one and is operated on very similar principles with slight modification. The St. Kitts factory has manufactured as much as 11,843 tons in a single season.

Encouraged by the success of the factories in Antigua and St. Kitts the same group of capitalists purchased in 1913 the large sugar factory in Trinidad, known as the Usine Ste. Madeleine, with the plantations connected with it. This concern was in financial difficulty and its future was very obscure. The knowledge gained at Antigua and St. Kitts proved of the greatest service and the working of the factory was soon put on a sound footing. This, coupled with some good fortune and the improvement of the sugar position, has resulted in considerable financial success, which has been greatly to the benefit of the colony.

The progress of events connected with the Antigua sugar factory, aided by the publication and discussion of the results obtained, was followed closely by the plantation owners of Barbados. In a short time substantial improvements were made in the small sugar factories of this colony and several small factories were established, embodying modern methods of sugar production, including the adoption of multiple crushing of the canes in the mills. Notwithstanding the fact that these factories are for the most part quite small, when judged by modern standards, they are reasonably efficient, since, as a rule, they have been evolved out of factories already in existence, and it has been possible in the majority of cases to effect the developments economically and with local capital. These small factories are in a very strong position, though it is probable that as developments ensue there will be amalgamations whereby larger factories will result, which will admit of greater efficiency and diminished cost in production. The present effect, however, is that a very large proportion of the sugar of Barbados is to-day manufactured in factories turning out refiners' crystals in place of the old and wasteful muscovado sugar, by which the prosperity of the colony has been greatly

enhanced and the situation much improved as regards the supplying of sugar during the stress of war.

It will generally be admitted that the central sugar factory established at Gunthorpes has amply fulfilled the expectations of its promoters. The effect of its successful working, coupled with full dissemination of the results of its operation, including statements of the methods employed and their cost, has reacted notably on the sugar industry of the British West Indies. Few Government investments have been more productive of good than the £15,000 contributed to that factory scheme by the wise prevision of the then Governor of the Colony, Sir Gerald Strickland.

Other matters besides sugar have had attention on the part of the Imperial and associated Departments of Agriculture.

In connection with cacao there has been much study of the pests and diseases to which this crop is liable, and material progress has been made in unravelling the complex stories which these troubles present. These matters cannot be dealt with in detail here; they are referred to at length in various departmental publications.

Attention, too, has been given in the experiment stations and on the estates of private owners to questions related to the planting, cultivating, and manuring of cacao trees, together with some consideration of the varieties grown. In this way information of a useful character has been gathered and disseminated concerning the manurial requirements of the cacao tree, the budding and grafting of cacao and the handling of cacao plantations generally. While much has been done, this field of work still presents many problems of interest, particularly in regard to the preparation of the cacao bean for market and the meeting of the requirements of the manufacturers of chocolate and cocoa.

Similarly, much work has been done in connection with the lime industry. The pests and diseases affecting lime trees have been carefully studied; the methods of cultivation and manuring of lime trees have been investigated, and also the preparation of lime products for market. In this last connection much has been done to improve the preparation of concentrated lime juice, the principal product of the lime, which finds its way into a number of manufacturing industries, notably for the preparation of citric acid and in dyeing and calico printing. Assistance was given in demonstrating the method of making citrate of lime which is used in the manufacture of citric acid. A comprehensive handbook has been published giving information concerning the cultivation and treatment of lime trees and the manipulation of their products.

In recent years an experiment station devoted to the cultivation of limes and the investigation of the problems incident thereto has been established in Dominica, and already many valuable lessons have been learned from it.

In connection with the work of the St. Lucia Department of Agriculture, a factory has been established for the purchase of limes on a profit-sharing basis and the preparation from them of essential oil and concentrated lime juice. The object of this venture was to encourage the planting of limes in that island and to afford a means of disposing of the fruit to those whose cultivation is too small to warrant the erection of the machinery required for its manipulation; at the same time the facilities thus offered are of material service to the larger cultivators in the earlier stages of their enterprise, for they can dispose of the small quantities of fruit which mature in the first few years of the growth of their trees, and thereby defer the expense of erecting machinery until they are in possession of sufficiently large crops to warrant the required outlay. This factory is equipped with steam-boiling plant, the use of which had been advocated departmentally for years, but which had been adopted by large growers in only a few instances. In the operation of this factory much valuable information has been acquired, for careful account is kept of the various operations; it has been demonstrated that by concentrating lime juice by steam heat the loss of citric acid by burning can be reduced to quite low limits, whereas, when the concentration is carried on over open fires, as was formerly the method commonly in vogue, the loss is frequently very large, and, in cases where the work is conducted carelessly, it may be disastrously so. As the outcome of this demonstration and the publication of the information thus made available, the introduction of steam-heated plants has become fairly general. By the use of such apparatus the quality of the product is considerably improved, so that it is capable of direct use in calico printing.

The operation of the St. Lucia Government lime-juice factory proved a great stimulus to the development of the lime industry in that colony and, incidentally, led to much greater attention being given to agricultural matters

there, so that important results followed from a simple expansion of departmental activity.

Something might be said concerning the work done in connection with crops which can hardly be regarded as staple industries, but which have local significance. For example, attention has been given to the production of maize, a matter of importance, for such maize is consumed as corn meal in all the islands. It really constitutes one of the principal foods of the people. The necessity for producing food during war conditions and even now, with production and shipping difficulties has stimulated this work. Corn driers and mills for the production of meal were erected in Antigua and in St. Vincent, the granaries thus created being operated by the agricultural departments, corn (maize) being purchased on profit-sharing lines and meal or grain sold for local consumption. This work stimulated production, not only on the part of those who sold their corn to the granaries, but also on the part of those who grew it for use on their own plantations, for the fear of loss of the grain from its becoming mouldy, due to insufficient drying in a damp climate, deterred many from growing maize. Now, with the assistance of central drying appliances by which grain can be dried at a small charge, a sense of security results and production is increased.

The Government granary at St. Vincent has been particularly successful and instructive. Through its operations a large proportion of the corn and corn meal consumed in the colony is now produced locally. A further interesting step was taken at this granary during the war; a small storehouse was built in which perishable commodities such as corn, rice, and peas, were stored under conditions whereby they were kept free from insect attack, after treatment, if necessary in the grain drier. This is of considerable convenience to dealers, for great difficulties are often experienced in storing commodities of this nature. The granary at Antigua has been less successful than that at St. Vincent.

Amongst other efforts to encourage minor industries, reference may be made to what has been done with onion-growing. Work was taken in hand, chiefly in Antigua, to ascertain whether onion-growing would be possible in these islands. The difficulties were investigated, and correct methods of practice were developed, so that, after some years of work and many interruptions and discouragements, an onion industry of moderate proportions has now been secured, mainly in Antigua, but with extension to some of the other islands. One interesting feature of this work is that the greater part of the onion crop is handled through the Onion Growers' Association, on a co-operative and profit-sharing basis. In developing matters to this point, much patient work was done by departmental officers in studying conditions of cultivation, the provision of the best type of seed, the control of pests and diseases, and the handling and marketing of the crop.

[*The second part of the paper and the Discussion will be printed in the next number of the "Journal."*]

THE PAPER INDUSTRY IN JAPAN.

The manufacture of paper has been carried on in Japan for many centuries. The product now generally known as Japanese paper was described by the early Dutch traders nearly 250 years ago. This product has served all the uses to which we put paper—book printing, covering for doors and partitions, writing and wrapping—and, in addition, has been utilised by the Japanese as a substitute for string, cloth, oilcloth, leather, and even wood, iron and glass. Its excellent lasting qualities and its superiority over machine-made papers have led to its utilisation for a number of purposes for which foreign paper would be unsuitable. These advantages are due to the fact that in making this paper the Japanese use the tough and pliant inner bark from three or four species of deciduous trees, possessing long, tough, fibre cells, and this bark is not cut or hacked in transforming it into pulp, but is separated by pounding and beating, so that the long cells remain unbroken.

In the manufacture of this paper the form is held so that the parallel splinters or threads run from left to right. The form is then lifted and lowered at right angles to this direction, causing the fibres of the material to lie in one direction. Japanese paper is consequently torn easily one way, but with difficulty the other. There is no special sizing or glazing, but each sheet has a rough and smooth side, resulting from the process of drying. The shaped sheets are pasted with a large brush on a smooth planed board to dry, and the side against the board remains much smoother than the outside surface. The smooth side is used for book printing and the two rough sides are folded against each other in binding the book, so that Japanese books consist of double sheets of thin paper.

From an interesting monograph on the paper industry in Japan, prepared by the Far Eastern Division of the U.S. Bureau of Foreign and Domestic Commerce, and from which the foregoing particulars have been taken, it would appear that all Japanese paper is very porous, and consequently cannot be written on with pen and ink, although

it is well adapted to the Japanese mode of writing with brush and india ink. Smooth, firm, machine-made paper would not absorb this ink so well, and is therefore not in demand. There is no bleaching, and all Japanese paper is of a yellow tint, although sometimes whitened by the ingredients used to soften it in manufacture.

Paper produced in Japan may be divided into two general kinds—Japanese paper as described above, and foreign or machine-made paper. Aside from the nature of the product, the two industries are further distinguished by the fact that the former is largely a household industry, and the latter a factory industry. The production of the Japanese paper in 1916 is officially valued at over £2,500,000; no figures as to quantity are available.

The principal raw materials entering into the manufacture of Japanese paper are the inner barks of the paper mulberry trees (*Broussonetia papyrifera*, *Edgeworthia papyrifera*, *Wickstroemia canescens*—a small bush related to the spurge laurel, *Morus alba*—white mulberry tree) and the *Aphananthe aspera*. The classes of paper produced from these materials are broussonetia papers, made from kodzu fibre; edgeworthia papers, made from mitsu-mata and from a mixture of mitsu-mata and kodzu; wickstroemia papers, made from the bast of morus alba; and suki-gaeshi papers, made from old or used papers.

The names of the various kinds of paper of each class, the province where made, the size of the sheets, and the number of sheets and the weight per quire, are given on p. 227.

Japanese papers derive their names almost exclusively from the towns or districts where they were originally made, and this geographical distinction perhaps accounts to some extent for the difference in grades. A short description of each of those figuring in the export trade is given below:—

Yoshino, manufactured in the town of Yoshino, in Yamato Prefecture, is a fine paper, used extensively in the lacquer industry. The mould is a net made of finely wrought bamboo sticks bound together with silk thread, and the texture of the product is indicated by the figures in the following table, one quire (50 sheets), or about 6·12 square metres, weighing only 35 grammes. The paper is so firm, however, that two or three layers used to filter thick lacquer are not only uninjured by the wringing and pressing through of the lacquer, but are afterwards smoothed out, dried, and used several times over for the same purpose.

Tengujo, literally "prize-crowned-labour," excels in fineness and pliancy the thinnest silk papers, and is also much stronger. It is manufactured in Mino Province, and is extremely well adapted for pasting on common window panes to make them opaque.

Mino is pure broussonetia paper made in the Province of Mino, and is noted for its firmness. It is used for covering woodenwares in the process of lacquering, for cord, and as a covering for the lattice of sliding doors, as it is very transparent. The 1916 production was 275,293 reams.

Hanshi, literally "half-paper," is so-called because of its common use in book manufacture, where only half the sheet is used, the rough surface being turned in. Its widest uses are for writing, printing, and paper handkerchiefs. Production in 1916 amounted to 3,266,195 reams of 100 quires (6·12 square metres) each.

Usuyo, or gampi, is at present used largely abroad as a copying paper in business houses, although its pliancy, smoothness, strength, and lightness will probably find other uses for it, as it becomes better known.

Torinoko is a semi-foreign paper which resembles parchment, and has enjoyed an increased sale abroad, especially in China, as a substitute for foreign parchments.

Renshi, literally "ream paper," is an imitation of the Chinese-sized papers put up in the same quantity, and is sold almost entirely in China.

Toyoshi, "Far East paper," is also sold almost exclusively to China, where it is used for a variety of local purposes.

Other varieties of Japanese paper, which do not figure in the export trade, but which are used largely in Japan, include the following:—Hankiri, resembling hanshi, used for account keeping and letter writing; nishi-no-uchi and shi-fu-gami, made from broussonetia bark in very large sheets, are exceedingly strong, and are used as a fabric; atsu-gami and senka are very thick strong papers used in making imitation leather and oil papers; another heavy, starched paper, ko-sugi, is cheaper, and is used for cleansing purposes; iyo-masa is a soft paper, and is well adapted for wrapping dried plants; hosho, one of the most valuable and expensive Japanese papers, is thick, very strong, of even texture and gloss, rich in starch, and often contains alum. It is used as the Government paper for all important legal acts, as a wrapping paper for expensive presents, and was formerly used for making paper-money. It is made in the celebrated five villages of Hoshi district in Echizen Prefecture.

Ju-mon-ji and jidzuki, otaki-gami, are large sheets of very thick, stout paper, used principally in the preparation of leather paper.

Suruga-ban-shi is a thin writing paper, and is also used for cleansing purposes and printing.

Shoji-gami contains about 20 per cent. of Edgeworthia pulp, and serves principally as the covering for lattices or shoji (sliding doors) and as a substitute for window-panes.

Ita-me-gami, or board paper, is made by fastening together, with wheat-starch paste, a number of sheets of common paper. This pasteboard is frequently made from waste-paper, old business documents, and other used paper, covered with a coating of fresh paper of good grade.

Papier-Mâché.—Hari-nuki, or Japanese papier-mâché, is also prepared from waste paper, but the process differs in that the hari-nuki is not prepared from paper reduced to pulp after being soaked in water, as is papier-mâché, but is made like pasteboard, the couching being done on wooden forms.

Name of Paper.	Province where made.	Size of Sheets.	Sheets per quire.	Weight per quire.
Broussonetia Papers:		Centimetres.	Number.	Grammes.
Yoshino-gami	Yamato	48 × 25·5	50	85
Mogami-gami	Uzen	31 × 27·5	50	25
Tengu-jo Pure	Mino	39 × 27	48	56
Tengu-jo Figured	do.	39 × 27	48	..
Mino-gami	do.	40 × 28	50	137
Mon-shi	do.	40·5 × 28	50	125
Han-shi	Tosa	32 × 24·5	40	67
Ko-ban-shi	Musaski	26 × 20	50	87
Hankire	Koshiu	52 × 39	50	200
Nisho-no-uchi	do.	47·5 × 35·5	50	254
Shi-fu-gami	Iwaki	53·5 × 41	50	256
Atsu-gami, okiban	Koshiu	44 × 33·5	20	240
Atsu-gami, koban	do.	42 × 29·5	20	200
Senka	Echigo	56 × 39	20	250
Do.	Iyo	44 × 32	20	220
Ko-sugi	Tosa	25 × 19·4	48	72
Iyo-masa	Iyo	52 × 39	48	372
Hosho	Echizen	57 × 44	48	852
Jidzuki-Otaka-gami	Musashi	60 × 42	20	600
Otaka-gami or Jumon-ji	Iwaki	66 × 46	20	800
Edgeworthia Papers:				
From Mitsu-mata only—				
Suruga-banshi	Suruga	62 × 48	50	250
Hankire	Koshiu	55 × 16	50	84
Nori-ire	do.	43·5 × 32	50	237·5
Mixture of Kodzu and Mitsu-mata bast pulp—				
Hanshi	do.	34 × 24	50	75
Shoji-gami	do.	40·5 × 27·7	50	135
Take-naga-gami	do.	67 × 26	50	325
Hosho	do.	47 × 34·5	50	375
Wickstroemia Papers:				
Gampi-shi, first quality	Mino	38 × 28	48	52
Usego, uncut gampi	do.	50 × 36	48	96
Kuwa-kami Paper:				
First quality	Koshiu	48 × 34·5	20	135
Second quality	do.	41 × 27·5	50	164
Suki-gae-shi Papers:				
Chiri-gami, grey	Musashi	40 × 26·5	50	150
Suka-gae-shi, best quality, grey-white	do.	31·5 × 26·5	50	75

Sheet after sheet of light waste paper is stuck with wheat-starch paste, and spread out over the form until the required thickness is obtained. The board is then cut, dried, and lacquered, and many small durable articles are made from it, such as dolls' heads, plates, saucers, tea caddies, and pipe cases. These articles closely resemble lacquered wood and far excel papier mâché in firmness and elegance. They are strong, durable, and surprisingly light and cheap. Kara-kami, or paper for hanging, is made in sheet size in a very small quantity, owing to the light demand.

Crêpe Paper.—By means of two very simple wooden tools—a lever press and mould—the smooth surface of several bark papers is twilled, and stiff cardboard is made soft and pliant, and given a surprising elasticity. The lever press is made either of evergreen oak or some other hard-wood, and stands on a foundation consisting of a large, heavy board, through which two perforated posts are fastened as tenon bearers, and between which lies the fulcrum of the lever. The moulds are large sheets of thick brown paper, which are grooved in parallel furrows in several directions, and show considerable elasticity when moistened. The paper to be twilled is wrapped around a wooden cylinder, varying in diameter from 2 to 3 inches, and in length according to the size of the paper, which also determines the height to which the tenon for the fulcrum of the lever is raised.

The sheets are moistened by sprinkling, and subjected for an hour to a mild pressure between alternate layers of wet paste-boards. The moistened sheets are then placed over the moulds about ten thick, and another mould placed on top. In this arrangement of layers the single sheets must lie even with the separating sheets, and have their edges parallel to those of the moulds. These layers

are wrapped tightly around the cylinder, making it about 6 or 8 inches in diameter. The cylinder is then diagonally wound round with a strip of hemp canvas and placed in the press, where pressure is applied by six or eight jerks on the roll, which is compressed in the direction of its axis. It is then taken out, and the thin sheets removed and placed on the forms or moulds in another position. After this process has been repeated eight or ten times in different positions, the paper is considerably smaller in length and width, but is stretched somewhat before being used. With each new operation the markings from the moulds become constantly finer and more regular, and shrinkage of the sheets and increasing softness and pliancy accompany this transformation.

Leather Paper.—Japanese leather paper is very soft, has great elasticity, and resembles calf leather. It is used in the manufacture of leather portfolios, tobacco bags, pipe cases, boxes, small chests, and other articles, and also as a floor covering, and as a protection from rain over wooden shoes. The paper is admirably adapted for hanging in salons. The process of manufacture is briefly as follows:—

1. The paper to be treated is spread out on a board, the smooth side up, coated with thin rice paste, to which lamp-black has been added, and then hung on horizontal poles to dry for several days.

2. The twilling is done by the same process employed in making crêpe paper.

3. A coating of perilla-seed oil is applied, and it is allowed to dry in the sun from five to twenty days, according to the time of the year.

4. A coating of paste solution mixed with the dye to be used, generally red oxide of iron, orpiment, indigo, india ink or other dyes, is put on.

5. When dried the paper is impregnated with lacquer by two workmen sitting opposite each other, who smear their hands with lacquer and beat them quickly on the sheet, after which it is dried on a frame.

6. If the leather paper is to be figured, carved wooden moulds are pressed in at the close of the crêpe process, and the colours applied by paper stencil plates. A metallic reflecting surface is obtained after the figures are made by fixing bronze powder with lacquer, and polishing when dry. Some papers are dried in the smoke of rice straw and then rubbed.

Paper Fabric.—The warp of Japanese paper fabric consists of silk threads and the woof of paper threads, made of broussonetia fibre. To make these threads, the paper is laid lengthwise over the narrow side of a thick board, provided with feet to lend it stability, and fastened at both ends with iron clamps. It is then cut into strips, long ribbons being produced by cutting the paper not quite to the end. These are rolled into thread on a stone slab by hand. The connecting edges are cut on both sides so far through that the single threads hang together by a width of only ¼-inch, and these connecting places are twisted to form a continuous thread.

In making paper fabric for clothing, the threads are twisted from right to left, like those of the silk woof for crêpe silk, and run in the fabric alternately, two right-twisted woof threads following two left-twisted ones. When finished the fabric is washed in boiling straw-ash lye, dried, and stretched. It acquires in this process an appearance of being twilled and is shrunk considerably. It is then dyed in various patterns. 150 years ago this fabric was very popular in Japan for women's summer clothing, but the more durable cotton fabrics have supplanted it at a much lower price, and now only a few small factories engage in the industry.

Oil Paper and Waterproof Paper.—Oiled papers are made for two purposes in Japan, one for use as transparent paper in lanterns, etc., and another for protection against water, as for umbrellas, and regular oil and leather paper. For this product perilla-seed oil is invariably used, and broussonetia paper of a stout grade is generally employed. The paper is made pliant, either by kneading, or by the crêpe process already described, and is pasted in the thickness desired with glue or paste made from the flour of the common brake. The sheets are then treated with a mixtnre of lamp-black (for black waterproof cloaks) and the juice of unripe persimmons, and dried in the sun for five days. Two coats of perilla-seed oil boiled with persimmon juice are then applied, drying taking place between the applications. The entire process requires about 15 days in good weather. Though far inferior in appearance and durability to oilcloth and western waterproof cloth, oil paper has served its purpose in Japan for several hundred years.

Since the oiled Japanese paper umbrella could not be used as a sunshade, nor the unoiled variety as a protection from the rain, the adoption of the silk umbrella, suitable for all weathers, has been rapid, and the Japanese manufactured silk umbrella is one of the few foreign articles used generally throughout the interior as well as in the large cities.

Foreign and Machine-made Paper.—The total production of European, foreign or machine-made paper in Japan in 1916 amounted to 558,588,246 lb., as compared with 197,506,826 lb. in 1907. The paper produced in 1916 was made in 51 modern mills, representing a total capital of more than £3,000,000. There has been a steady increase in production in recent years, as a result of which the imports of every variety of paper have decreased considerably, and there is reason to believe that the industry is firmly enough established in Japan to withstand any foreign competition. This is especially true of those kinds of paper, the output of which is on a large scale, and in the manufacture of which the Japanese are organising for scale production by concentrating the industry on modern lines in the hands of one or two large companies.

GENERAL NOTES.

Canals and Inland Waterways. — In the House of Commons on February 16th Mr. Neville Chamberlain, in a question addressed to the Minister of Transport (Sir Eric Geddes), asked whether he was yet in a position to state the policy of the Ministry as to the future ownership and administration of canals and inland waterways; whether he was aware that the revised railway rates were likely to have the effect of driving heavy and bulky traffic off the water on to the railways, and whether he would cause a further revision to be made with a view to the distribution of traffic between railways and canals. Mr. A. Neal (Parliamentary Secretary of the Department) said that Sir E. Geddes was proposing to appoint a Committee, of which he hoped Mr. N. Chamberlain would consent to be Chairman, "to consider what development of canals and waterways is practicable, having regard to the financial position at the moment." In answer to a supplementary question, Mr. Neal said it was not the fact that the whole of the canals, or the majority of them, were owned by the railway companies. Mr. Macquisten said the key ones were. Mr. Neal, replying to another question, said that to carry out in its entirety the report made by the Railway Commission would involve the expenditure of many millions. Before advising the House to sanction such an expenditure Sir E. Geddes desired to be fully advised upon the question in its present relationship to all transport problems.

Coal in the United Kingdom, 1918.—The total output of coal in the United Kingdom in 1918 was 227,748,654 tons, and the value £238,240,760, showing a decrease in the output of 20,750,586 tons and an increase in the value of £30,453,866 on the figures for 1917. The average price of coal was 20*s.* 11·06*d.* per ton in 1918 as compared with 16*s.* 8·68*d.* in 1917. The quantity of coal exported, exclusive of coke and manufactured fuel and of coal shipped for the use of steamers engaged in foreign trade, was 31,752,904 tons. France received over 16½ million tons, Italy over 4 million tons, Egypt nearly 1¾ million tons, Gibraltar over 1½ million tons, Norway over 1¼ million tons, Malta nearly 1¼ million tons, and Sweden and Denmark each over 1 million tons. The amount of coal remaining for home consumption was 184,358,158 tons, or 4·385 tons per head of the population.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m. :—

February 25. — James Currie, C.M.G., Ministry of Labour (Training Department), late Principal, Gordon Memorial College, Khartoum, "Industrial Training." The Right Hon. Sir Robert S. Horne, K.B.E., K.C., M.P., Minister of Labour, will preside.

March 3.—William James Garnett, First Secretary, H.B.M. Diplomatic Service, "Mongolia from the Commercial Point of View."

March 10.—H. M. Thornton, "Gas in relation to Industrial Production and National Economy." Sir Robert A. Hadfield, Bt., D.Sc., F.R.S., will preside.

March 17. — William Worby Beaumont, M.Inst.C.E., "Street Passenger Transport of London."

March 24.—L. Gaster, "Industrial Lighting in its relation to Efficiency."

April 14.—Joseph Thorp, "The Fundamental Basis of Good Printing."

April 21.—Air-Commodore Edward Maitland, C.M.G., D.S.O., A.F.C., "The Commercial Future of Airships."

April 28.—Charles H. Sherrill, "Stained Glass."

Indian Section.

Friday afternoon, at 4.30 p.m. :—

March 19.—Sir William S. Meyer, G.C.I.E., K.C.S.I., Financial Member of Council of the Governor-General of India, 1913-18, "The Indian Currency System and its Developments." The Right Hon. Lord Chalmers, G.C.B., LL.D., will preside.

Thursday afternoons, at 4.30 p.m. :—

April 15.—Brigadier-General Lord Montagu of Beaulieu, C.S.I., "Roads and Transport in India."

May 20.—Sir George Cunningham Buchanan, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

Date to be hereafter announced :—

Sir Valentine Chirol, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

Colonial Section.

Tuesday afternoons, at 4.30 p.m. :—

March 2.—G. F. Scott Elliot, M.A., B.Sc., F.R.G.S., "Trade Routes for the Empire in Africa." Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., will preside.

May 4.—Professor William A. Bone, D.Sc., Ph.D., F.R.S., "Lignite."

Indian and Colonial Sections.

(Joint Meeting.)

Date to be hereafter announced :—

Professor Sir John Cadman, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E., "The Oil Resources of the British Empire."

Dates to be hereafter announced :—

GRAILY HEWITT, "Rolls of Honour."

CHARLES CROWTHER, "The Arts and Crafts of Japan." (with examples from the author's private collection).

WILLIAM CRAMP, D.Sc., M.I.E.E., "Pneumatic Conveying Plants, with special reference to the Transport of Grain."

CANTOR LECTURES.

Monday evenings, at 8 p.m. :—

CHARLES FREDERICK CROSS, B.Sc., F.R.S., F.C.S., "Recent Research in Cellulose Industry." Three Lectures.

Syllabus.

LECTURE II. — FEBRUARY 23. — *The Cellulose Industries.* Cotton-spinning — Investigations of factors of process and qualities of products—Raw cotton and (normal) bleached cotton—Artificial silk, controlled hydration of celluloses by chemical process and a critical re-investigation of paper-making processes—Twisted paper yarns.

LECTURE III.—MARCH 1.—*Cellulose and Derivatives.* Nitrates—Acetates—Progress of research and industry—Specific volumes of cellulose and hydrates—Data of fundamental importance, scientific and industrial—The problems of constitution.

WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.

May 3, 10, 17.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, FEBRUARY 23...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. C. F. Cross, "Recent Researches in the Cellulose Industry." (Lecture II.)

TUESDAY, FEBRUARY 24...Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. T. L. Llewellyn, "Lighting Conditions in Mines, with special reference to the Eyesight of Miners."

University of London, School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Mr. A. D. Innes, "The Mogul Period of the History of India." (Lecture III.)

Royal Institution, Albemarle-street, W., 3 p.m. Professor E. Wilson, "Magnetic Susceptibility." (Lecture II.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Sir F. J. E. Spring, "Restoration of a Cyclone-Damaged Breakwater-end in Madras Harbour," and "Coastal Sand Travel near Madras Harbour."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Dr. C. A. Swan, "Wanderings in Italy."

Colonial Institute, Central Hall, Westminster, S.W., 3.30 p.m. Mr. K. Fairbridge, "Australia and Child Emigration."

Horticultural Society, Vincent-square, Westminster, S.W., 3 p.m. Mr. J. Hudson, "The Cultivation of Fruits under Glass with a minimum of Fire Heat."

Industrial League and Council, Carpenters' Hall, Throgmorton-avenue, E.C., 5.15 p.m. Mr. T. E. Naylor, "Trade Unionism and Output."

Central Hall, Westminster, S.W., 7.30 p.m. Messrs. Mundy and Roe, "Profit Sharing."

Zoological Society, Regent's-park, N.W., 5.30 p.m. 1. The Secretary, "Report on the Additions to the Society's Menagerie during the month of January, 1920." 2. Mr. E. G. Boulenger, "On some Lizards of the Genus *Chalcides*." 3. Mr. N. S. Lucas, "Report on the Deaths in the Gardens in 1919: with Notes on Rickets and Avian Enteritis." 4. Mr. S. Hirst, "Revision of the English Species of Red Spider (Genera *Tetranychus* and *Oligonychus*)."

WEDNESDAY, FEBRUARY 25..ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. J. Currie, "Industrial Training."

Geological Society, Burlington House, W., 5.30 p.m. Mr. H. C. Sargent, "The Lower Carboniferous Chert Formation of Derbyshire."

British Psychological Society, 8, Queen-square, W.C., 6 p.m. Dr. H. M. Vernon, "The Effect of Change in Hours of Work on Output."

THURSDAY, FEBRUARY 26...Cold Storage and Ice Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. Mr. H. J. Deane, "The Development of the Cold Storage of the Port of London Authority."

Ophthalmic Opticians, Institute of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m.

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Dyers and Colourists, Society of, Leeds. 1. Mr. W. G. Sewell, "Sulphide Dyes." 2. Mr. N. Chappell, "Hydrosulphite."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. H. Smith, "Illustrations of Ancient Greek and Roman Life in the British Museum." (Lecture II.)

Electrical Engineers, Institution of (Joint Meeting with the Rontgen Society and the Electro-Therapeutic Section of the Royal Society of Medicine), 1, Wimpole-street, W., 5 p.m. and 8.15 p.m. 1. Dr. R. Morton, "On the Efficiency of High-Tension Transformers as used for X-ray Purposes." 2. Major C. E. S. Phillips, "The Problem of Interrupted and Fluctuating Currents." 3. Mr. R. S. Wright, "High-Tension Transformers."

Concrete Institute, 296, Vauxhall-bridge-road, S.W., 7.30 p.m. Mr. E. F. W. Grimshaw, "Reinforced Concrete Fences and Posts."

China Society, School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Captain H. J. Hinks, "The Burmese Shan States and the Tai."

FRIDAY, FEBRUARY 27...Royal Institution, Albemarle-street, W., 9 p.m. Mr. W. B. Hardy, "Problems of Lubrication."

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. F. Ward, "The Animal World Seen from under the Water."

Engineers and Shipbuilders, North-East Coast Institution of, Mining Institute, Westgate-road, Newcastle-on-Tyne, 5 p.m. Mr. G. S. Baker, "Flying Boats: the Formation and Dimensions of their Hull."

University of London, University College, Gower-street, W.C., 5 p.m. Dr. T. Borenius, "Mediæval Art." (Lecture VII.)

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

Metals, Institute of (Sheffield Section), Mappin Hall, The University, Sheffield, 7.30 p.m. Messrs. E. A. Smith and H. Turner, "Standard Silver: its Production and Working Properties."

SATURDAY, FEBRUARY 28...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Positive Rays." (Lecture II.)

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FRIDAY, FEBRUARY 27, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, MARCH 1st, at 8 p.m. (Cantor Lecture.) Mr. CHARLES FREDERICK CROSS, B.Sc., F.R.S., "Recent Research in Cellulose Industry." (Lecture III.)

TUESDAY, MARCH 2nd, at 4.30 p.m. (Colonial Section.) G. F. SCOTT ELLIOT, M.A., B.Sc., F.R.G.S., "Trade Routes for the Empire in Africa." COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., will preside.

WEDNESDAY, MARCH 3rd, at 4.30 p.m. (Ordinary Meeting.) WILLIAM JAMES GARNETT, First Secretary, H.B.M. Diplomatic Service, "Mongolia from the Commercial Point of View." BRIGADIER-GENERAL SIR PERCY MOLESWORTH SYKES, K.C.I.E., C.B., C.M.G., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, February 23rd, DR. M. O. FORSTER, F.R.S., in the chair, Mr. CHARLES FREDERICK CROSS, B.Sc., F.R.S., delivered the second lecture of his course on "Recent Research in Cellulose Industry."

The lectures will be published in the *Journal* during the summer recess.

ELEVENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 25th, 1920; THE RIGHT HON. SIR JOHN TUDOR WALTERS, M.P., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Aiyar, S. Paramesvara, M.A., B.L., Travancore, South India.
Cantrell, T. B., Liverpool.
Gurtu, Pundit Sri Krishen, M.A., M.Inst.C.E., Morar, Central India.
Healey, William, B.Sc., Assoc.M.Inst.C.E., Assoc.M.I.Mech.E., London.
Knox, George, F.G.S., Cardiff.
Walker, Frederick H., B.Sc., A.I.C., Newcastle-on-Tyne.

The following candidates were balloted for and duly elected Fellows of the Society:—

Barker, Sir Francis H., London.
Binns, A. S., Winnipeg, Canada.
Bowring, Edward John, Winchfield, Hants.
Cadbury, L. J., Northfield, Birmingham.
Ferguson, Louis, Port Glasgow, N.B.
James, Albert Alfred, J.P., Edgbaston, Birmingham.
Kelman, George Arthur Duff, London.
Mann, G. L. C., West Guildford, West Australia.
Mason, Rev. W. A. Parker, M.A., F.R.Hist.S., Manchester.
Mather, Right Hon. Sir William, LL.D., M.Inst.C.E., Bramshaw, New Forest.
Morris, Wing-Commander Alfred Drummond Warrington, R.A.F., C.M.G., O.B.E., London.
Naylor, Heaton, Rawdon, near Leeds.
Notley, Fenton George, Maclean, New South Wales, Australia.
Phillips, Grevile Herbert, Hereford.
Robinson, Commander Samuel M., U.S. Navy, San Francisco, California, U.S.A.
Rogers, John H., London.
Taylor, Alfred, York.
Thomas, Frank, London.
White, Tyndale, Brentwood, Essex.
Wright, Francis, Vancouver, B.C., Canada.

A paper on "Industrial Training" was read by Mr. JAMES CURRIE, C.M.G., Ministry of Labour (Training Department), late Principal, Gordon Memorial College, Khartoum.

The paper and discussion will be published in a subsequent number of the *Journal.*

COVERS FOR JOURNALS.

For the convenience of Fellows wishing to bind their volumes of the *Journal*, cloth covers can be supplied, post free, for 2*s.* each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

TROPICAL DEPARTMENTS OF AGRICULTURE, WITH SPECIAL REFERENCE TO THE WEST INDIES.

By Sir Francis Watts, K.C.M.G., D.Sc.,
Imperial Commissioner of Agriculture for the West Indies.

(*Continued from page* 225.)

Work connected with other industries might be described did time permit. Detailed reference may, however, be made to one industry, the establishment of which as a staple industry has been one of the marked successes of departmental work and which illustrates very completely the difficulties and complexities which have to be met in introducing a new industry. It is not sufficient to provide the seed or planting material and to point to a demand for the commodity in question: all the details of cultivation, seed production, control of pests and diseases, preparing and marketing the crop, and many others, have to be dealt with. These matters imply the work of a variety of individuals, each capable of dealing with that part of the work in which he possesses skill and knowledge.

The introduction of the Sea Island cotton industry, and its development to such a position that the welfare of more than one West Indian community now depends upon it, may be worth recording. When sugar-growers were at their wits' end to know what crops to cultivate in view of the losses which they were incurring over sugar production and the threatened extinction of the sugar industry, attention turned to cotton, which had been cultivated in the West Indies in former days. Some experiments in cotton cultivation which had been conducted in one or two of the departmental experiment stations attracted the notice of one planter in St. Kitts. On the strength of these experiments, he determined to make a trial of cotton-growing on a small scale. The results were promising, and they were watched with interest by the officers of the agricultural department. As the outcome of the preliminary trials, it was decided to attempt the cultivation on an extended scale in St. Kitts and in the neighbouring island of Montserrat. The cotton grew promisingly, but difficulties soon cropped up. It will be interesting to trace some of them as indicating what is necessary in building up a new industry.

In the following account little regard is paid to chronological sequence or to distinguishing between the localities in which the difficulties occurred: it will be understood that there was much overlapping as regards the time and manner in which events took place.

It was speedily seen that very special care would have to be taken to obtain the right kind of seed to produce the most suitable type of cotton, and to ensure the production year by year of seed of the required type. Deterioration of type was recognised in the lots of cotton first grown. In some other countries this deterioration soon led to failure of similar attempts to establish an industry. Consequently efforts were made to procure the best types of seed available, and Sir Daniel Morris, then Imperial Commissioner of Agriculture, visited the Sea Island districts of South Carolina in order to learn all that he could of the methods of cultivation and seed production followed there. During this visit he procured several tons of seed of a fine type of Sea Island cotton, which were distributed throughout the cotton-growing areas of the British West Indies. Concurrently, much attention was given by departmental officers in several colonies to questions pertaining to seed production and the selection of good types. As the outcome, not only was seed deterioration arrested, but several good types of Sea Island cotton have been produced, so that the quality of the cotton grown in these islands has tended to improve instead of to deteriorate.

As a further step in this connection, the study of plant-breeding problems in relation to cotton is being carried on in a scientific manner. This work is of very great complexity, and for its prosecution requires the services of workers highly trained in the modern science of genetics. In order that this may be done effectively, assistance has been given by the Department of Scientific and Industrial Research, and a special worker is now engaged in investigating the intricacies of Sea Island cotton-breeding. Already results of a far-reaching character have been secured, and some of the leading principles connected with the raising of the required types of cotton are being elucidated, so that this work, in combination with that of the workers in the several experiment stations, gives assurance that good types of cotton will be maintained in these islands, that desirable new types may be evolved, and also that, as the requirements of the spinners are known, it will be possible to produce the types of cotton which they desire. The importance of this will be recognised when

it is stated that the Sea Island cotton is the finest cotton now grown and that the West Indian types compare very favourably indeed with those which have been produced elsewhere. Sea Island cotton is produced in only one or two districts; practically these are confined to certain areas in Carolina, Georgia and Florida, in the United States, and the West Indian areas into which the introduction has recently been made. The invasion of the Mexican boll weevil, which has now reached almost all the areas in the Southern United States where Sea Island cotton has been grown, makes the cultivation of this cotton practically impossible there. Present production, therefore, depends mainly on the West Indies, though efforts are being made to grow the crop elsewhere. These facts are of the highest significance to the British fine-spinners who use this type of cotton.

No sooner had Sea Island cotton-growing assumed moderate proportions in the West Indies, than a number of pests and diseases made their appearance. Almost any one of these would have sufficed to kill the infant industry if means had not been found to control it. Not only are these pests and diseases new in the experience of the cultivators, but several are new to science. It was necessary to study them in thorough detail and to devise means of combating them. In all this the various officers of the Agricultural Departments worked energetically in conjunction with the planters.

The nature of the work may be judged to a certain extent from the following account of some of the pests and diseases which have to be dealt with.

Cotton worm (*Alabama argillacea*, Hubn.) appeared in great abundance, completely denuding the fields if uncontrolled, thus threaten ing ruin to the crops. The habits of this insect were studied, together with those of the natural enemies which might be capable of holding it in check, of which there are several, and means of controlling the pest by dusting with arsenical powders were developed. The position now is well understood, both by the officers of the agricultural departments and by the planters, including the peasant cotton-growers, who require, however, much supervision on the part of the departmental agricultural instructors in order to prevent the invasion of the pest and its spread to their neighbours. Several tons of arsenical powders, such as Paris green, London purple, and calcium arsenate, may be required for use in a season when this pest is prevalent.

Much alarm was caused in the early days of the industry by the appearance of a new and hitherto unrecorded pest, which attacked all parts of the cotton plant, except the roots, causing the formation of small galls, or blisters, and the distortion and stunting of the leaves and other green parts. This was shown to be due to the invasions of a microscopic mite, *Eriophyes gossypii*, Banks, an insect new to science, new also to agricultural experience, for which the remedial treatment was not known. The investigation of this pest involved much work and many remedial measures were tried; ultimately it was found that the best means of controlling it is by instituting close seasons during which no cotton plants are permitted to be in existence, all cotton bushes being destroyed prior to the date fixed for the beginning of the season, and no planting being permitted before its expiration. Regulations to this effect are enforced by law in the several islands where cotton-growing is of importance.

Another pest which threatened the industry is the flower-bud maggot, *Contarinia gossypii*, Felt. This is the maggot of a minute fly, or midge, which lays its eggs in the very young flower-bud of the cotton. From the egg develops a small maggot, which causes the blossom to fall off. The attacks of this pest are sometimes so severe that the attacked fields produce practically no cotton at all. This pest, too, was entirely new to science and to agricultural experience. It has not been found possible to devise direct remedies, and the best means of control yet found is the careful destruction of infected material, and the regulation of the planting so as to avoid the later periods when the pest tends to become abundant. This pest still remains somewhat of a menace to the industry.

Red maggot, *Porricondyla gossypii*, Coquillet, the larva of a small fly, attacks the stem of the cotton plant in some localities; the cotton aphis, *Aphis gossypii*, Glover.; the cut worm, *Prodenia*, spp., various scale insects; red spider, *Tetranyphus gloveri*, Banks; the Lachnophus weevil, have all, at various times, caused trouble and anxiety to cotton-growers, and have been the subject of study and investigation on the part of the scientific staff and the field officers of the departments.

In addition to trouble arising from insects attacking the growing plant, there are those which attack the stored seed, and these have had to be dealt with.

Many fungus diseases have proved alarming, and in some cases disastrous, to cotton-growers in the West Indies. Some of these attack the

leaves, as leaf rust, due to *Uredo gossypii*; leaf mildew, caused by an undetermined fungus, and angular leaf spot, due to *Pseudomonas malvacearum*. Other leaf diseases are known which are not parasitic, but which appear to be due to adverse physiological causes; amongst these are the curly-leaf disease, and the so-called loggerhead disease. A red leaf disease symptomatic of potash shortage is at present much in evidence in St. Vincent.

Of great importance are the fungus and bacterial diseases which attack the boll—amongst these are rots caused by Phytophthora and other fungi; a serious rot caused by *Pseudomonas malvacearum*, characterised at the outset by lesions on the outer surface of the boll; but most important of all is the disease known as the internal boll disease. As this disease has given rise to some of the most interesting, complex, and successful work of the Imperial Department of Agriculture, involving the co-operation of other workers in the local departments, it may be dealt with at some little length, for it well illustrates the nature of the work which departments of agriculture are called upon to do when the introduction of new crops is under consideration, and the remarkable complications which ensue.

The internal boll disease of cotton was observed in the early days of cotton cultivation, but its real nature was not ascertained until after some ten years of work, for it presents complications which proved baffling. When the diseased bolls were examined on various occasions, it was first thought that the rotting of the lint was caused by a bacterium; further investigations led to the discovery in other instances of a fungus of a peculiar type; further research showed that at least four related species of fungus are to be met with, and in a few cases bacteria may also be involved. Seeing that no external lesions are visible, the question of the manner in which the disease, whether in its fungus or bacterial form, gains entry to the boll, presented difficulty. From the presence of internal proliferations associated with tiny puncture marks, it was suspected that the plant-sucking bug, *Dysdercus*, known locally as the cotton stainer, might be involved. After long inquiry and careful work, it was finally proved that Dysdercus does convey the infection, so that it was evident that remedial measures must include the elimination of this insect. Here at once further difficulty arose, for no parasite or natural enemy is known to attack Dysdercus to any appreciable extent; few birds will eat it; and it cannot be controlled by placing poisonous materials on the cotton bolls, for it feeds by sucking the juices from the seeds and so avoids the poison. It will readily be appreciated that this situation gave rise to much work and to no little anxiety. Finally, it was agreed that the best methods of attack would be by combining starving the insect with hand-collecting. From the fact that these insects occur in enormous numbers and breed with extraordinary rapidity, hand-collecting would be of little avail unless the process of starving them tended to reduce their numbers. The adoption of the close season already mentioned was looked to to reduce their numbers, but it was soon observed that the insects were carried over in great abundance from one season to another owing to their finding sustenance on other plants. It became necessary, then, to deal with the other food plants, and legislative powers were taken to enable officers of the Agricultural Department to enter upon anyone's land and destroy the food plants of the cotton-stainer. The cotton-growers themselves, in many instances, entered actively into the campaign, and destroyed such food plants on their properties and assisted the agricultural officers in their efforts to destroy them elsewhere. Investigation shows that two trees were principally concerned in the maintenance of the insect in the absence of the cotton plant, namely, *Thespesia populnea*, a malvaceous tree common on the beaches, known locally under the names "John Bull" or Seaside Mahoe, and others, and the second the Silk Cotton, *Eriodendron anfractuosun*. It was no easy task to destroy all these trees throughout an island, or even to reduce their numbers to insignificance, but by vigorous and well-directed activity this task was accomplished in St. Vincent, and is in process of accomplishment in other places. Those who are familiar with the tropics will realise that the destruction of such huge trees as the silk cotton, long famous for its bulk and fantastic shape, presents peculiar difficulties, nor are these difficulties lessened by the fact that these trees are often regarded by a superstitious negro peasantry as the abode of evil spirits, jumbies or duppies, who will wreak vengeance on those who destroy their haunts. Fortunately, it is also a matter of superstition that less harm is likely to happen if the cutting of the tree is done by a left-handed man. Now the Agricultural Superintendent in St. Vincent happened to be ambidextrous, so it was diplomatic for him to begin the work with a few left-handed cuts, when the timorous work-people could continue it, proclaiming under their

breath, "Its no me do it; its Mr. S." In this way the work was carried to such a successful point that the trees were destroyed, practically eradicated, but the superstitions were to some extent supported, for a falling tree killed one of the workmen, thus showing how dangerous it is to meddle with the supernatural.

So successful has been the result that the cotton-stainers are very largely under control in St. Vincent, and on the belated arrival of small swarms are capable of being kept within bounds by hand-collecting. This work has altered the whole aspect of cotton-growing in St. Vincent. The prevalence of internal boll disease not long ago threatened to extinguish the cotton industry there, for in that colony difficulty is experienced in reaping an early yield owing to the prevalence of boll-rotting diseases encouraged by the heavy rains, while the later yield in drier weather was ruined by internal boll disease. From these causes the production of cotton per acre in St. Vincent fell steadily until it had reached a point when the industry ceased to be remunerative at ordinary prices for cotton. Since the adoption of the remedial measures here detailed the yield has been practically doubled, though it is still lower than is desirable, and it is hoped that the ability to combat this major evil will give such encouragement to all concerned that it will now be found possible to deal effectively with other troubles and to bring up the yield of cotton in St. Vincent to a high figure, comparable with that attained in islands less embarrassed by disease and difficult climatic conditions.

It would be possible to extend considerably this list of matters which have required consideration at the hands of departmental officers in connection with the establishment of the cotton industry. Something might be said about the knowledge which had to be obtained concerning the ginning of the cotton, for much of the information that had to be gained was acquired through the aid of the agricultural departments, and in some instances departmental officers had charge of ginneries and their working. Similarly, a good deal of departmental assistance has been given in the marketing of cotton and in formulating the knowledge that has been gained in regard to the various types of cotton and their suitability for the requirements of the spinners. Sufficient, however, has been said to show how considerable and how varied is the departmental work which has been invoked in order to establish this one industry.

The simple outline so far given of some of the work done in recent years may serve to show how different is the outlook of a modern agricultural department in the tropics from that of the botanic garden in which it had its origin, and whose functions amongst many others it still continues to discharge.

It is evident that these changes of function and outlook involve changes in the men who have charge of the several branches of these institutions. For work in the botanic gardens men were required who had botanical knowledge coupled with horticultural skill extending to some knowledge of the economic uses of the plants introduced and recommended for wider propagation. If these workers were skilled in knowledge of how to deal with these plants as crops when grown on a large scale so much the better, but the planter was supposed to take care of this aspect of the case. The process of evolution into the agricultural department, however, soon called for the help and advice of specialist workers whose knowledge in various directions went beyond that of the practical agriculturists; hence it occurred that in the evolutionary process, first chemists were called for to advise concerning soils, fertilisers, and the manipulation of plant products such as sugar, lime juice, cacao, and other products. Then it was soon found that insect pests were threatening most of the crops grown, in some cases to the extent of destroying them, so entomologists were added to the departmental staffs; but this was found to be insufficient, for when insect injuries were investigated it was found that many of the troubles were due, not to insects, but to fungi and bacteria, so recourse had to be had to mycologists.

Hence we find that in most tropical agricultural departments which have evolved in the manner indicated, the scientific staff consists of a chemist, an entomologist, and a mycologist, while the botanic garden, with its associated experiment station, often grown to dimensions which overshadow the botanical aspect, is under the charge of an officer who has had training in botanical knowledge coupled with that pertaining to horticulture verging into agriculture; his assistants are usually men who can carry information regarding the recognised and approved methods of agricultural practice to cultivators, including in this work advising as to the application of methods recently made known, either in regard to particular crops, or the remedial measures to be adopted to control the pests and diseases to which they are liable.

The members of the staff of an agricultural department so equipped must, in order to be of service to the agricultural community, get into touch with agricultural practice proper, so that there is a disposition for the workers added to the departments to endeavour, and rightly, to gain an acquaintance as complete as possible with agricultural practice; and in the final result we have tended to get agriculturists with a chemical, an entomological, or a mycological point of view.

This is where matters appear to stand to-day in most tropical agricultural departments, but the process of evolution does not end here. We are now confronted in the tropics with the necessity for investigating agricultural problems of great complexity concerning which our guides in other countries and our text-books are unable to help us. New knowledge is necessary for the solution of many of the problems on which successful progress in agriculture in the tropics depends. There is need for those who can give us further information concerning the various plants grown, and to be grown, as tropical crops; information concerning the physiology of the plants, their adaptability to their surroundings, both customary and new; information concerning the influence of climate as affecting crops and the limitations exercised thereby, and generally as to the relation of the several plants to their environment—all work of the botanist, plant physiologist, or ecologist, as yet almost unknown in relation to tropical agriculture.

Similarly, many soil problems require investigation in the light of the flood of increasing knowledge relating to soil physics, soil biology, and many cognate matters. These things call for the work of specialists of a class hitherto not considered necessary in the tropical agricultural departments.

Much more remains to be done in connection with plant pests and diseases than the limited number of entomologists and mycologists have been able to undertake, and we may expect substantial addition to their ranks. On the scientific side concerned with investigations and the making of additions to knowledge there is room for much expansion—for many problems, some of immediate practical bearing, are calling for solution—and it is along these lines that we may look for developments in the near future.

On what may be regarded as the more immediately utilitarian side, such as concerns the agricultural superintendents, the curators and those having charge of matters immediately concerned with the production of crops, there has been a great expansion in outlook. This is evident when it is remembered that an agricultural superintendent in one of our smaller colonies is now expected, not only to maintain his botanic garden and his experiment, or demonstration station in good order, so as to afford enlightenment to the agriculturists of the community, but he must be alert to recognise the appearance of disease, troubles, or deficiencies in the staple crops as well as the minor crops of his district. He is looked to to provide, or indicate the manner in which can be obtained the material required for planting various crops and either himself to undertake or to show how there can be undertaken, the best methods of maintaining the most desirable types of the crops that are cultivated locally. He is looked to, to a large extent, as the medium through which the researches and investigations of the scientific officers reach the agriculturists and are applied in practice. He is required to assist actively in such matters of economic interest as the development of those industries which require State assistance, such as the operation of cotton ginneries, corn driers, granaries, lime-juice factories, onion buying and marketing institutions, and other agencies of a semi-commercial or fully commercial character; to give assistance in establishing such organisations as agricultural credit societies, to be active in connection with the local agricultural society, that important medium through which the agricultural department can make known its views and researches to the planters, and by means of which the planters in turn can make known their requirements to the department. All this and much more implies wide knowledge, common sense, and special aptitude on the part of any man who becomes a successful agricultural superintendent.

Thus regarded and equipped in the manner discussed, tropical departments of agriculture are organisations of great complexity, involving in many of their aspects a high degree of specialisation on the part of their workers. This gives rise to two problems—the training of the men to be engaged in the several activities of the departments and the manner in which such departments may be organised and held together.

In regard to the first of these considerations, most of the workers in the West Indian departments have gained the greater part of their tropical training and experience in connection with the Imperial Department of Agriculture

and the several local agricultural departments associated with it. In their several degrees the men engaged have had good sound general training in the subjects more immediately connected with the duties which they have come out to undertake, in so far as this training can be given in institutions outside the tropics. Their tropical training has been acquired in the course of the performance of their duties. Seeing that the several West Indian islands present great diversity in regard to their agriculture and in regard to the problems to which this diversity gives rise, and seeing that by their association into an organised group through the activities of the Imperial Department of Agriculture, there has been brought into close relationship a fairly large body of men of diverse training, knowledge, and outlook, the Imperial Department of Agriculture has proved a good training-ground, and men have gone from it and its associated departments to all parts of the tropical world, where they have successfully undertaken a great variety of duties as workers in botanical and agricultural establishments of various kinds and as scientific investigators and advisers connected with such establishments.

The future, however, calls for something more definite in the way of training than this, for there is a demand for a greater number of men than can be provided in this way, and for men whose work and duty lie beyond the confines of official agricultural departments. Trained men of many and diverse grades are required for plantation work all over the tropical world, so that there is immediate need for the establishment of a Tropical Agricultural College, whereby the present deficiencies in the way of training may be made good, and a supply of trained men be provided. The call of the tropics for development is urgent, but the men capable of intelligently obeying the call are relatively few in number.

A further aspect of an agricultural college is that it would provide a means of extending work in regard to research and abstract investigation. Associated in some manner, as it should be, with an agricultural department, it should help to extend the research work of the department, while in turn receiving inspiration with regard to the real needs of tropical agriculture in its practical aspects.

This brief reference to a tropical agricultural college must suffice: the subject is one which is receiving earnest attention at the moment on the part of responsible authorities, headed by the Secretary of State for the Colonies. It is a subject which will doubtless have consideration on the part of the Royal Society of Arts as one of the many institutions which take an interest in the maintenance and development of our tropical possessions, now recognised as being of such importance to our national welfare.

With regard to the second problem—namely, the manner in which the departments may be organised and held together—something may be learned from the history and working of the Imperial Department of Agriculture.

Where a number of relatively small, scattered communities occur, such as exist in the West Indies, it is essential to have some centralising or grouping organisation, for it is not possible to maintain the full machinery for agricultural administration in each small community; this function the Imperial Department well fills. It presents the advantage that, through the medium of the scientific officers maintained on its staff, it is able to undertake researches and to give advice concerning matters with which local observers and agriculturists are not fully informed, or which, as so frequently occurs, are entirely new to experience, and have to be completely investigated before advice can be given concerning them. As a centralising organisation it is able to assist in ensuring that the agricultural work in each of the scattered communities is maintained on similarly advanced planes and that knowledge gained by experience is rapidly passed from one to the other. Through its agency it has been possible to induce greater uniformity in connection with matters of common interest, notably in such matters as concern the regulations regarding plant pests and diseases and those relating to measures taken for the prevention of the introduction of these into the several islands. Through its operations much has been done to ensure continuity of agricultural policy; it is of material service in advising concerning the staffing of the several departments and in aiding the selection of suitable officers and their transfer to advantage when vacancies occur, and in many matters of administrative detail.

An important function is the assistance it is able to afford in framing the agricultural policy of the communities, directing attention to desirable, or necessary, lines of work, supervising the work when in progress, and often preventing retrogression under the influence of narrow or mistaken lines of policy, agricultural as well as administrative.

These and similar functions are capable of

being exercised when advice is sought in regard to the larger colonies, and in this connection it is felt that there is scope for extended usefulness.

It has been the purpose of these remarks to indicate in some degree the manner in which the several West Indian agricultural departments have been evolved from the simple gardens intended to foster plant introductions; it will be recognised that in this progress great complexity has arisen, rendering desirable the existence of centralising institutions, failing which it would be difficult, or impossible to maintain the progress already instituted. The impetus gained may enable the work to be maintained for a time, but the momentum would diminish, and first the smaller communities and then the larger would fall back into a condition of isolation and stagnation in which they would be unable to maintain themselves in face of the economic struggle and competition which must inevitably soon make their pressure acutely felt once more. Closer grouping, improved means of agricultural education, and increasing agricultural research are all called for in greater degrees in the future. The work instituted by Mr. Joseph Chamberlain some twenty years ago with a view to relieving the necessities of the West Indies has borne good fruit, and its continuance should be assured by the formulation of well-thought-out plans for the future.

[The paper was read by Captain Arthur W. Hill, M.A., Sc.D., F.L.S.]

DISCUSSION.

The Chairman (Sir David Prain), in opening the discussion, said the Society was indebted to the author for an exceedingly luminous history of the recent progress in West Indian agriculture, while it was perhaps more indebted to him for having given an account of the stewardship of the Imperial Department over which he presided. In both those respects the paper was intensely interesting to all West Indians, past and present. With reference to the account the author had given of how it had become necessary in certain colonies for agricultural departments to take the place of the older botanical departments, in small colonies the question of cost came in; it was not possible to afford two departments of the kind. One had to be considered as a luxury which must be dispensed with, and as a result the botanical departments had suffered. Only in the larger dependencies, such as India, was it possible to continue the existence of both departments. There was a considerable disadvantage in the loss of a botanical department. An agricultural department did excellent work in instructing the producer of crops, but, unfortunately, in all countries in which agricultural interests were the principal concern it was necessary for the Administrator to know something not only about the crops but about those natural vegetable products which were the sources of revenue of the colony or dependency which he had to administer. An agricultural department could instruct the grower, but it was not always quite so easy, and it needed a botanical department, to educate the Administrator.

Sir George R. Le Hunte, G.C.M.G., late Governor of Trinidad and Tobago, desired to bear testimony to the undiluted success of the work which had been done by the Imperial Department of Agriculture in the West Indies. It might be summed up by saying that Kew had been brought to the islands instead of the islands going to Kew. He was very glad to meet Captain Hill again. He represented Kew at the West Indian Agricultural Conference in Trinidad when he (the speaker) was there. The detailed account given in the paper of the many tropical plant diseases which had to be dealt with reminded him of the remark of a friend of his that gambling on the Stock Exchange was a solid security compared to embarking on tropical agriculture. But although agriculturists had a great many troubles to face, they now had the means of circumventing and combating them, and one of the greatest helps that the tropical planter had ever possessed was the agricultural departments in the West Indies. Most of them were the children of Kew and the Board of Agriculture. Such a department existed in Trinidad, and they were always delighted in that Colony to welcome the Director or any of the officers of the Imperial Department of Agriculture. He remembered that when the Department was started he was in Dominica, and an arid-looking part of a sugar estate was then purchased and had now been turned into one of the most beautiful tropical gardens in the world. He recollected a planter friend of his in Dominica sending a box of leaves from a lime tree to the Agricultural Bureau in America asking for advice in the treatment of a disease which affected the leaves, and he subsequently received a reply requesting that in future the leaves from separate trees should be sent in separate parcels, because thirteen different diseases had been discovered in the leaves which he had sent. As a matter of fact, they came from only one tree. When a planter was faced with such difficulties it was necessary for him to turn to some doctor to help him, and he now possessed the advantage of being able to consult the officers of the Imperial Department of Agriculture. Reference was made in the paper to the establishment of an agricultural college in the West Indies, and he trusted that if a discussion took place at any future time before the Society on that question he would be invited to attend, because he foresaw a rather big war between the interested parties, and he would be very anxious to see which way the battle went.

MR. A. HOWARD, C.I.E., M.A., F.L.S., Imperial Economic Botanist to the Government of India, said he desired in the first place to discuss the question of the best method of procedure on the part of scientists who went out to the tropics to advance agriculture. It had been found in India that a very successful method was for the scientists to take up the subject, so that they combined in one person a practical experience of agriculture and of a particular science. There were now a large number of experimental stations in India, in which all the details were managed by the scientific men in addition to carrying out their own particular work. A large portion of the paper was taken up with references to diseases of various crops, and in that respect a good deal of new ground had been broken in India in the last two or three years. The orthodox view was that the diseases were caused either by insects or by fungi, and that the best method of attack was to study the life history of the insects or fungi and to endeavour to find some remedial method of control. The subject was now being looked at in India from a somewhat different point of view. It had been found that insects and fungi, although important factors in the case, were not everything, and results in the treatment of disease were now being obtained by considering the physiological activities of plants, particularly the distribution of the root system and the effect of the physical texture of the soil. During the last two or three years it had been found possible to grow cotton in parts of India with a rainfall of 70 inches absolutely free from disease, a thing that was considered impossible in days gone by. That had been brought about by selecting soils in which the physical texture was practically perfect and in which healthy root development was possible; and a large number of similar results were now being obtained at other centres. The treatment of disease now appeared to be very much more hopeful. It was not a question so much of spraying as of improving the physical texture of the soil, and selecting types of plants with root systems which were specially adapted to particular classes of soil.

MR. C. SANDBACH PARKER, C.B.E., said that as one long interested in sugar-growing in British Guiana he desired to add his personal testimony to the value of the Imperial Department of Agriculture in the West Indies. British Guiana, like Trinidad, had its own department, and in addition there were individuals who were doing pioneer work; in fact, British Guiana in that respect was rather more modern than some of the West Indies, but he thought there was not the slightest doubt that the more the Imperial Department of Agriculture was used the more valuable it would be to tropical agriculture, not only in the West Indies, but in British Guiana and other tropical countries. It was only necessary to refer to the wonderful statistics which were compiled by the Department of Agriculture of America and her colonies in connection with the growth of sugar to find out what could be done by the co-ordination and extension of their efforts in that direction in the West Indies and British Guiana. Unfortunately, during many years past the interests of the West Indies were left very much to West Indians themselves, except for the help of Mr. Chamberlain, but changed ideas were now apparent in the Imperial Government, and there was a desire to develop the agricultural industries of all the tropical possessions of the Empire. He hoped that had come to stay, and if it did so there was an era of prosperity in front of the agricultural industries of the British possessions in the tropics such as they had never experienced before.

MR. A. ABBOTT said the Department of Scientific and Industrial Research, with which he was connected, was engaged in the task of establishing a number of research associations. Each of the associations consisted of a group of British manufacturers who, feeling that they had common interests, had embarked on a scheme of co-operative research. About nineteen of those associations had so far been approved, of which six or eight were at work. It became obvious at a very early stage that if those associations existing in England began their work of research on the raw materials as they entered these shores, they would be too late; it was necessary to make an earlier start and to carry on research as to the method of production of the raw materials. It was evident that it was impossible to improve the quantity of mineral productions very largely—at any rate, it could not be improved indefinitely; the number of animal products was not large, but the number of vegetable products grown in tropical countries filled an extremely long list, including timber, flax, cotton, jute, cocoa, rubber, oils, seeds, spices, drugs and certain dyes; and that pointed to the necessity of carrying on research on a large scale. He did not know the exact means that should be devised for the purpose, but it was necessary that they should be considered. Looking at it from the point of view of the man on this side who knew nothing of the West Indies, there were several directions in which help could be accorded. First of all it was possible to communicate to the tropical departments abroad the results of research carried on in this country in pure science at the universities. Secondly, it was very desirable that the producer abroad should be in very close contact with the user or the manufacturer on this side. That was one of the factors which had not been developed as much as it might have been in the past. The user in this country ought to be able to tell the producer just what he wanted and why he wanted it, and the producer in the tropical country must have some knowledge of what the user in this country really needed. Thirdly, tropical countries must depend on this country in the main for their supply of technical men. Until quite recently, if a manufacturer

wished to have a scientific man in his works he selected a chemist as being the one scientific man who could help him. It was just beginning to be recognised that the physicist as well as the chemist could do extraordinarily useful work in industry. It had scarcely been recognised, in this country at any rate, that the botanist and the entomologist had a very wide industrial field for their work; but it was quite impossible for the country to secure an adequate supply of men of that type unless it could be shown that a career awaited them in industry. As soon as the possibility of a career was obvious to young men, they would follow their bent and take up that particular line of work.

Mr. G. Moody Stuart said the paper contained a record of twenty-one years' unobtrusive work, which was hardly known except to those who were personally connected with it. As he happened to be in that position, he desired to take the opportunity of saying that he firmly believed the Agricultural Department had been of untold value to the West Indies. The Sea Island cotton industry was not only made but saved by the Agricultural Department in the West Indies, and many estates and several islands had been brought out of very uncomfortable uphill conditions into a position of comfortable well-being by the development which had taken place, a development entirely due to the work of the Department. Not a particle of what had been done in sugar development in Antigua would have been done except for the Department. The factory there had now completed fifteen years' work, and during that time it had saved sugar to the value of £430,000 which would otherwise have been wasted. That was not a bad single item to the credit of the Department. The greater part of that money had gone to the planters, and through them a fair portion had filtered to the estate managers, overseers, and labour. The author had referred to the necessity of the Department being maintained from Imperial funds, because that had been the main element of its success in the past. Personally he strongly supported the suggestion, because he felt sure that if a change were made it would be a very dangerous thing for the Department. It might be said that the West Indies ought to be able to bear their own burdens, but as a matter of fact they were bearing them to the full now. The sum of £130,000 had been given as a grant-in-aid, in addition to which the Mother Country had also borne the cost of the headquarters, but she had received much more than that back again in excess profits and income tax, which would never have been paid but for the work of the Department. A large proportion of the estates and many of the factories were owned in England, and on the profits that were made the Treasury received income tax, so that the Imperial Treasury would be looking only at one side of the account if they looked at the expenditure only. The success of the Department was due to the chemists and the men who had come from Kew, but he ventured to suggest that when the next vacancy occurred a practical agriculturist with scientific knowledge should be appointed, one well acquainted with practical farming, drainage and manures. The chemists had trusted to the planters themselves being well up in the best methods of agriculture, but as a matter of fact they were only employing methods which were known to their forefathers. Agriculture had taken such big strides in recent years that he was sure that if a man who was thoroughly well up in practical farming was appointed it would be to the benefit of the colonies. He desired to refer, in conclusion, to the spirit in which the Department had been run from first to last. It was not a typical Government Department. Usually in approaching a Government Department one felt that one was going to an authority which might or might not condescend to be interested in one's case; but in going to the Agricultural Department one always felt that one was asking for professional advice in the same way that a client went to a lawyer or a patient to a doctor, and that one was given the advice as willingly and readily as any professional man gave advice to his client.

Dr. Louis W. Sambon said that, having had the privilege and pleasure of visiting the Lesser Antilles in the instructive company of Sir Francis Watts, he eagerly seized the opportunity of expressing his high regard for the writer of the paper and his admiration for the work he had carried out in the West Indies. While travelling with Sir Francis, who was on a tour of inspection, he could not help wishing that the medical and sanitary work were conducted on lines such as were being followed by the Imperial Department of Agriculture. As a student of ecology in a different field, he desired to emphasise the importance of a college such as had been outlined by the author, because no doubt the teaching of the principles of ecology would enable them to obtain men capable of raising good crops and of controlling the pests and diseases of plants. The ancients had achieved wonders in agriculture. Had time permitted he would have liked to remind them of the terraced agriculture of the ancient Mexicans, of the hanging gardens of Babylon, of the Roman transportable forcing-houses, of the controlling of crop-pests by their natural enemies. An Assyrian clay cylinder, 2,500 years old, in the British Museum, handed us down Sennacherib's boast that cotton-trees throve better in his gardens on the Euphrates than in their native land. At that time, whilst Hindu, Hellenic, and Egyptian girls danced in transparent muslins—true "webs of woven wind," as they were called in Sanskrit literature—the ancient Peruvians swaddled their dead in cotton bands. Moderns should at least equal, if not surpass, their endeavours, and thus be worthy followers of the ancients, whose inheritance they were so fully enjoying.

DR. C. A. BARBER, C.I.E., F.L.S., said he had the greatest possible sympathy with the suggested agricultural college, because he felt that tropical agriculture was entering upon a new intensive phase which was not only directly but indirectly caused by the late war. There was a vast need for raw products, which were being produced in immense quantities, but nevertheless they could not be obtained in manufacturing countries. As a result there was an increasing tendency to deal with those raw products on the spot, an increase in the number of the factories in the tropics thereby being brought about. A large increase was taking place in the departments of agriculture all over the tropical world, and many new men were required from this country to carry on that work and extend it. It was necessary with regard to diseases to study the actual growth of plants more carefully, and not to be content with simply naming the disease, the fungus or the pest, without attempting to ascertain why it was caused and without endeavouring to provide a remedy for it. He very much doubted whether a single agricultural college would be sufficient for the West Indies. In India there were a series of regular agricultural colleges, but none in the colonies. They were needed in the West Indies, and soon would be in West Africa, the Transvaal and Natal, Uganda and British East Africa, Mauritius, Ceylon, Queensland, and Oceania. If men for those colleges were to be supplied, it was necessary to do more work in England, and in that respect he did not think the present method of obtaining men for the tropical agricultural departments was likely to succeed unless some scheme of co-ordination between the new agricultural colleges and those in this country was put into force—some scheme of preliminary training to bridge over the gulf between the knowledge of agriculture in temperate climates and in the tropics. From long experience of the tropics, he found that it took sometimes two or three years before a man who had been trained in an English college was in a position to adapt himself to his surroundings and to be of much use.

SIR EVERARD IM THURN, K.C.M.G., K.B.E., C.B., in proposing a hearty vote of thanks to Sir Francis Watts for writing the paper, and to Captain Hill for reading it, and at the same time informally thanking Sir David Prain for his kindness in presiding over the meeting, said that he saw, perhaps more than anybody else present, the beginning of the operations which Sir Francis Watts had described. Forty years ago he was resident in British Guiana, before the Botanical Gardens there existed. He saw the extraordinarily good work which the first Curator, the late Mr. G. S. Jenman, did, and the subsequent work performed by his successor, Dr. Harrison. The contrast between the botanical garden work and the agricultural side of the work had been in his mind during the reading of the paper. He quite saw the necessity for practical purposes that the agricultural tendency should take the lead, but at the same time he could not help feeling a certain amount of regret at the dropping of the botanical garden side of the question. Speaking from his own long experience, he was perfectly certain that the care which was given to the introduction of minor products and not merely the main products, be they sugar-cane or coconuts, should be a very important feature of any agricultural department; and though attention must be paid to commercial products, he hoped the smaller and minor industries would not be overlooked. He did not mean for a moment to suggest that they were purposely neglected, but there was a strong suspicion that they were being allowed to drop out. A good deal had been said in reference to the advantages of a large Agricultural Department formed by the union of various smaller institutions, and he would like to see that principle extended still further. In any Imperial Agricultural Department the outlying parts of the world, which had practically been untouched from the scientific agricultural point of view, had not yet been taken much into consideration. In that connection he desired to utter a note of warning, that the conditions of agriculture in the Pacific and in the West Indies were so extraordinarily different that when men were being trained for agriculture in the West Indies it was necessary to bear in mind that, if they were transferred by any chance to Oceania, the conditions there would be very different. For instance, the conditions under which sugar-cane was grown in Fiji and in the West Indies and British Guiana were extraordinarily different.

SIR LOUIS DANE, G.C.I.E., C.S.I., in seconding the motion, said he was very glad to find that an attempt was being made to overcome the difficulties that at present existed in regard to the importation of Indian labour into the West Indies. The West Indies depended to a very large extent upon India for their labour, and he hoped therefore that the present difficulties would be surmounted. He thought, however, it would be wise for the administrators of the West Indies to realise that it would be quite impossible for them to secure Indian labour in the future upon the old terms. He had no doubt whatever that Indian labourers would be forthcoming, but it would be necessary for the West Indies to take them absolutely as free labourers, and if they did so plenty of excellent labour would be available. Speaking as an Indian Administrator, he was able to say that he had never heard of any trouble at all with the returned immigrants from the West Indies or British Guiana, who were peaceful and prosperous men, although trouble had been experienced when Indians had returned from other parts of the world. He agreed with Sir Everard im Thurn that it was absolutely necessary to have not only an agricultural department and colleges, but also a botanical department and botanical gardens. The two really did not serve the same purpose. The first dealt with commercial agriculture; the

second dealt with the introduction of new specimens which were to a great extent entirely beyond the scope of the economic botanist employed in the Agricultural Department. The West Indies as a field for agriculture was practically a new one, but in India the circumstances were entirely different. India possessed the accumulated experience of centuries of agriculture, which was often crystallised into the very wise saws of the peasantry, which embodied great truths. The agricultural experts who went out to India from this country had at first a tendency to regard the natives as absolutely wanting in all knowledge of correct agriculture. There never was a greater mistake. Every year it was being found that Indian practice was based upon sound agricultural principles, although the people who practised them did not know the why and wherefore for them. He was glad to say the agricultural experts were beginning to find that it was necessary to do what was suggested in the paper, namely, study the local conditions and associate themselves very closely with local agriculturists of experience, and most happy results were hereby being produced. He could not help thinking that if there was a closer union between the Imperial Agricultural Department of the West Indies and the Agricultural Department in India they would be able to benefit each other very largely. A great many of the difficulties, especially those affecting cotton and sugar-cane, that were experienced in the West Indies also obtained in India; in fact, the same problems cropped up in all the various dependencies, and it was therefore essential that there should be free communication between them, and also a certain amount of personal visitation.

The resolution of thanks was put and carried unanimously.

Captain Hill, after acknowledging on behalf of Sir Francis Watts and himself the vote of thanks, said it was only possible for him in the short time at his disposal to refer very briefly to the remarks made by Mr. Howard. The Mycologist of the Imperial Department of Agriculture, when visiting Trinidad, found that the trouble experienced by the planters with regard to the frog-hopper on the sugar-cane was not so much linked up with insects or fungi as with the physiological conditions under which the plants were growing, and by taking steps to remedy the deficiencies in the cultivation the pest had been largely brought under control.

Sir Charles Lucas, K.C.B., K.C.M.G., in expressing regret at his inability to attend the meeting, writes: I should have been glad to have been there to bear witness to the Imperial Department of Agriculture in the West Indies, to the splendid support given to it by the Directors of Kew Gardens, from which it gained Sir Daniel Morris, and to the very able services of the writer of the paper, Sir Francis Watts. It is not too much to say that the present regeneration of the West Indies from the decay into which they had fallen towards the end of the last century has been very largely due to the work of the Department of Agriculture.

Sir Daniel Morris, K.C.M.G., D.Sc., F.L.S., who was also prevented from being present, and to whom an advance copy of the paper was sent, writes: It contains a remarkably full and careful account of the evolution of agricultural efforts under the fostering care of the Imperial Department of Agriculture, and brings out very forcibly the value of scientific research in promoting the welfare of our tropical possessions. It is quite in keeping with the traditions of the Royal Society of Arts that this paper should be read under its auspices, as more than 150 years ago it presented its gold medal to Dr. Young, then head of the Botanic Garden at St. Vincent, in recognition of the flourishing state of that institution. A great deal has been accomplished in the West Indies since those days. Among some of the results of enlightenment in regard to agricultural matters, it has been shown that the public revenue of the colonies before the war had increased from two and a half million sterling to nearly four million; while the total trade had increased in value from seventeen million to nearly twenty-seven million sterling. In the case of the comparatively new cotton industry, which owes its existence so largely to the efforts of the Imperial Department of Agriculture, the exports in recent years have reached a total value of nearly two million sterling. Sir Francis Watts has rightly drawn attention to the fact that while the Imperial Department of Agriculture has continuously trained a large staff for experimental work in the West Indies, it has also turned out capable men, of university standing, who now occupy responsible positions in other portions of the tropics. Further, it has been successful in winning wide appreciation of improved methods of cultivation and the value of science among members of the planting community, with the result that the provision for the maintenance of well-equipped staffs, laboratories, and botanic and experiment stations, voted by the local legislatures, has increased from £14,000 to more than £60,000 per annum. Having been so closely interested and taken so active a part in the development of the West Indian Colonies for a period of nearly forty years, I may be permitted to place on record that I am fully convinced of the necessity of the continuance of the valuable work that is being done by the Imperial Department of Agriculture, and I hope that the proposal to establish a central agricultural college for training capable men to assist in the further development of the West Indies will meet with the success it deserves. Sir Francis Watts has very modestly said very little of his own share in the great work that has been accomplished in the West Indies. He was my most valued colleague for many years in the work of the Imperial Department of Agriculture, and the great success of his efforts in connection with the

establishment of central sugar factories at Antigua and St. Kitts, and indirectly also at Jamaica and Barbados, will always be most closely and gratefully associated with his name.

SUGGESTED DEVELOPMENT OF THE EUCALYPTUS INDUSTRY IN AUSTRALIA.

The development of the eucalyptus industry as a way of employing returned soldiers is being urged in Australia, writes the United States Trade Commissioner at Melbourne. There are scores of different kinds of eucalyptus trees, but only a limited number (about six) are of any commercial value. The two most important varieties are the peppermint and the mallee. Good results can be obtained by men working in a small way with either of these species, but anything attempted so far in a large way has not met with much success for many reasons, chiefly because of the difficulty and expense of obtaining large areas of land. With the two species mentioned large areas are necessary because the trees only grow in patches. Thus a distiller who holds a lease of 1,000 acres of land may only have 100 acres that are of any good to him. The mallee gives the best and most valuable oil for medicinal purposes. No mallee, however, can be very profitably worked, according to a practical distiller, unless the scrub has been first rolled down and burned. Suckers spring up very quickly after burning, and it is from these that the distiller gets his profit. Thus in a small way distillers do very well at Wyalong, where large areas have been rolled down by farmers for wheat-growing; but the land is mostly private property there, and unreasonably high rentals are charged for lands worthless for any other purpose. The mallee is being rapidly exterminated for wheat-growing purposes where the soil is at all good. Firewood is scarce for the same reason, and cartage is becoming more expensive as the cutters go farther afield. None of these disabilities, it appears, would exist in a large belt of mallee in Riverina, but private distillers would not take it up because there is no water available and the mallee would need to be rolled down and burned. There is profitable and permanent work in this big belt of mallee for a large number of men, says one distiller, a fact which it is suggested the repatriation authorities might well take into consideration. There they could settle a large number of men and bring into profitable use thousands of acres of Crown lands at present considered absolutely worthless because of the eucalyptus scrub which grows in such profusion. The cost, it is said, would be far less *per capita* than any other means of repatriation so far proposed.

THE KAURI FORESTS OF NEW ZEALAND.

The Department of Lands and Survey, New Zealand, have issued as a pamphlet the report drawn up by Mr. D. E. Hutchins for the New Zealand Government on the Waipoua Kauri Forest, the most important of all the remaining forests of this tree. It lies to the north-west of Auckland, in a somewhat inaccessible area near the Waimaku River, and covers an area of about eleven miles by nine, in a region of heavy mean rainfall, the annual average being well over a hundred inches. The soils within the forest area are poor, the dampness renders the country useless for fruit, and not good for sheep, while the poorness of the pasture makes the keeping of dairy cattle unprofitable. It is estimated, indeed, that it takes five acres to feed one cow. The forest at present is not in good condition, but Mr. Hutchins thinks that it may be restored, and that the process of reconstruction is the most profitable way of using the land.

At present the stand of timber is low and uneven. In places there may be only one kauri tree in ten acres, while the maximum stand is fifty to sixty per acre. The cubic content of timber in the individual trees may, however, be very high, and this is especially true when the kauri stand is thin, and the trees are scattered among other species. In nearly pure stands the trees never appear to grow to great dimensions. On the other hand, Mr. Hutchins maintains that individual kauri trees have reached a greater size than any other tree, exceeding even the Californian sequoias. He mentions two examples in an area close to the Waipoua Forest, each of which contained 295,788 feet of sawable timber, about double the amount of the largest of the Californian big trees known, and equivalent to the production of nearly three acres of good European forest.

As regards natural regeneration, Mr. Hutchins states that though there is little evidence of this in the interior of the Waipoua Forest, it does occur upon its margins. The seed has apparently the power of lying dormant for many years, and only germinates when the conditions are favourable, especially when light is admitted. In other words, it would appear that, in harmony with the slow growth and longevity of the tree, reproduction is slow, and occurs naturally for the most part only when forest fires or destruction by wind make a break in which seedlings may spring up.

Proposals are made for working the forest and for improvements which, it is calculated, would during a period of a hundred years give the same average amount of employment and money returns as successful dairying in this region. At the close of this period the reconstructed forest would give far higher profits and much more employment than dairying.

ONTARIO LINEN INDUSTRY.

With the installation of modern wet-spinning machinery completed, a Guelph (Ontario) company is now turning out wet-spun linen yarns from flax grown in the province. This company is the only one in Canada making wet-spun linen yarn, which is the basic material of the finer linen

fabrics. The mill has a potential output, it is stated, of 750,000 lb. of tow (linen) yarns, and 150,000 lb. of linen (line) yarns per annum. The company expect to receive the maximum amount from the Government bounty of $25,000 a year, which has been offered on linen yarns spun in Canada from Canadian flax.

A flax spinning mill, operating in conjunction with the linen mill, makes this industry a self-contained one, able to turn out linen fabrics, including the finer grades, from raw flax to finished goods. During the war the plant was running on cotton and union goods, because of the difficulty of getting linen yarn; but with a steady supply of Canadian spun-linen yarns now assured, it is turning out all the finer linen goods as well as the coarser grades.

The development of flax-spinning, writes the United States Consul at Kingston (Ontario), will have a stimulating effect on the growing of flax by Ontario farmers. Ontario flax has in the past been found acceptable by Irish manufacturers in the production of the famous Irish linens. A newly invented Canadian machine to harvest the flax which, for purposes of spinning, must be pulled, not cut, is expected to reduce labour costs greatly, and there seems no reason why flax production and spinning, with the complementary industry of linen weaving, should not become one of Canada's important industries.

OBITUARY.

Henry Gribble Turner.—Mr. Henry Gribble Turner, who died in Cairo on February 15th, had been a member of the Society since 1883. He entered the Indian Civil Service in 1864, and was posted to Madras. Here he quickly won the confidence of the primitive tribes inhabiting the Eastern Ghats of the Vizagapatam district, of which he was collector and agent to the Governor at the time of his retirement in 1889.

After he had left the service Mr. Turner devoted himself to the economic development of India. He was mainly instrumental in shipping from India the first ton of manganese, the annual export of which now amounts to 600,000 tons. He was also the pioneer of the export of Indian magnesite, which is of high quality and proved most useful during the war. Another project initiated by him is a great harbour at Vizagapatam to serve the uplands of Central India—a project which is at last about to be begun; while the great and flourishing planting estates of Travancore owe both their conception and inception to him.

Albert E. Reed.—Mr. Albert E. Reed died at his residence at Woking on February 21st. He was born in Devonshire, and established his reputation as a papermaker in the West of England, founding, in 1895, the firm now known as Messrs. Albert E. Reed & Co., Ltd., of Cannon Street, E.C., with mills at Tovil, Maidstone, Horton Kirby, Dartford, and Farncombe. He was one of the pioneers in the use of wood pulp for papermaking, and established a large pulp industry in Newfoundland. During the war he served as a member of the Royal Commission on Paper. In 1906 he contested the Wandsworth Division as a Liberal, and was only defeated by a narrow majority.

He had been a member of the Royal Society of Arts since 1887.

GENERAL NOTES.

Reorganisation of the Board of Trade.—Particulars regarding the reorganisation of the Board of Trade, which has been proceeding since June last, are officially announced. The duties of the Department have been arranged under two Joint Permanent Secretaries, Sir Sydney Chapman, K.C.B., who deals with all questions affecting General Policy, and Mr. H. A. Payne, C.B., who has charge of Administration and Finance. There are eight principal Permanent Departments: (1) Marine, (2) Commercial Relations and Treaties, (3) Industries and Manufactures, (4) Industrial Property (including Patent Office), (5) Power, Transport and Economic, (6) Bankruptcy, (7) Companies, (8) Statistics. There are also a number of sub-departments, including some of which are temporary and are concerned with such matters as the Profiteering Act, Meat Supplies and Enemy Debts. There are also two large Departments which hold somewhat special relationship to the Board of Trade, viz., the Department of Overseas Trade (Development of Intelligence) and the Coal Mines Department. The internal Administrative Council, which has been established and meets frequently to deal with current business involving questions of policy, is presided over by the President. The other members are Sir H. Llewellyn Smith, Economic Advisor to the Government; Mr. W. C. Bridgeman, M.P., Parliamentary Secretary to the Board of Trade; Sir Hamar Greenwood, M.P., additional Parliamentary Secretary to the Board of Trade; Sir Sydney Chapman; Mr. H. A. Payne; Mr. Ashley, Assistant Secretary in charge of the Industries and Manufactures Department; Sir W. H. Clark, Comptroller-General of the Department of Overseas Trade; Mr. Fountain, Assistant Secretary in Charge of the Commercial Relations and Treaties Department; Mr. Hipwood, Assistant Secretary in charge of the Marine Department. Various other officials attend meetings when subjects specially concerning their respective departments are under consideration.

Light and Heat from Gas.—Professor W. Bone, Sir Robert Hadfield, Mr. W. H. Patchell, and Mr. H. James Yates, as a deputation from the Fuel Economy Committee of the British Association, waited upon the President of the Board of

Trade on February 2nd to place before him certain considerations which, in their view, should receive full weight in legislation regulating the supply of gas. Professor Bone said they agreed that the basis of charge to the consumer should be the actual number of thermal units supplied to him. They would, however, substitute in the Fuel Research Board's recent proposal the words "ascertained net calorific value" of the gas for the words "declared gross calorific value." What mattered to the consumer was the actual heating effect he received from the gas as ascertained by independent tests. The Board, which had originally recommended a pressure of not less than two inches of water at the exit of the consumer's meter, had since reduced its proposal to a pressure of not less than two inches of water in any main or service pipe of two inches diameter. The interesting point for the consumer was the adequacy of the pressure in his own pipes and not the pressure outside in the gas mains. It was also of great importance that as constant a pressure as possible should be maintained. The Committee were also of opinion that gas undertakings should be compelled to pay great attention to the removal from gas of the highly poisonous cyanogen compounds. His remarks were illustrated by diagrams taken from experiments. The conclusion of the Committee, he pointed out, was that the proportion of methane (non-poisonous) in coal-gas should not be less than 20 per cent. and the permitted proportion of carbonic oxide (highly poisonous) not more than 20 per cent. Mr. Yates said that in the view of the Committee the minimum number of thermal units should be not less than 450 B.Th.U. net. If gas undertakings supplied gas of lower heat efficiency a large part of the existing gas appliances would become useless. Sir Auckland Geddes promised to give full consideration to the opinions and facts which had been submitted to him.

Demand for Silk Hats.—Notwithstanding the high price now charged for a silk hat—two guineas for a medium quality is a very modest price nowadays—a Stockport correspondent of the "*Times*" *Trade Supplement* reports that the factories both there and at Denton have orders on hand to keep the operatives busy for at least six or nine months. There seems little chance of hatters returning to the longer working day, as was recently urged by the Manchester Chamber of Commerce. There has been another increase in the cost of the high-class silk plush, which is almost exclusively of French manufacture, and according to the same correspondent the price of silk hats is bound to rise before long, it is suggested to the extent of 8*s.* to 10*s.* a hat. The additional advance in the price of the chief material used in the making of silks is attributed to the requirements of the United States, whose merchants are outbidding our own, and sending up the prices by leaps and bounds. The high cost of shellac is mentioned as a contributory cause.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m. :—

March 3.—William James Garnett, First Secretary, H.B.M. Diplomatic Service, "Mongolia from the Commercial Point of View." Brigadier-General Sir Percy Molesworth Sykes, K.C.I.E., C.B., C.M.G., will preside.

March 10.—H. M. Thornton, "Gas in relation to Industrial Production and National Economy." Sir Robert A. Hadfield, Bt., D.Sc., F.R.S., will preside.

March 17.—William Worby Beaumont, M.Inst.C.E., "Street Passenger Transport of London."

March 24.—L. Gaster, "Industrial Lighting in its relation to Efficiency."

April 14.—Joseph Thorp, "The Fundamental Basis of Good Printing."

April 21.—Air-Commodore Edward Maitland, C.M.G., D.S.O., A.F.C., "The Commercial Future of Airships."

April 28.—Charles H. Sherrill, "Stained Glass."

May 5.—Dr. C. E. Kenneth Mees, "A Photographic Research Laboratory." Sir Henry Trueman Wood, Chairman of the Council, will preside.

Indian Section.

Friday afternoon, at 4.30 p.m. :—

March 19.—Sir William S. Meyer, G.C.I.E., K.C.S.I., Financial Member of Council of the Governor-General of India, 1913-18, "The Indian Currency System and its Developments." The Right Hon. Lord Chalmers, G.C.B., LL.D., will preside.

Thursday afternoons, at 4.30 p.m. :—

April 15.—Brigadier-General Lord Montagu of Beaulieu, C.S.I., "Roads and Transport in India."

May 20.—Sir George Cunningham Buchanan, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

Date to be hereafter announced :—

Sir Valentine Chirol, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

Colonial Section.

Tuesday afternoons, at 4.30 p.m. :—

March 2.—G. F. Scott Elliot, M.A., B.Sc., F.R.G.S., "Trade Routes for the Empire in Africa." Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., will preside.

May 4.—Professor William A. Bone, D.Sc., Ph.D., F.R.S., "Lignite."

INDIAN AND COLONIAL SECTIONS.
(Joint Meeting.)

Date to be hereafter announced :—

PROFESSOR SIR JOHN CADMAN, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E., "The Oil Resources of the British Empire."

Dates to be hereafter announced :—

GRAILY HEWITT, "Rolls of Honour."

CHARLES CROWTHER, "The Arts and Crafts of Japan" (with examples from the author's private collection).

WILLIAM CRAMP, D.Sc., M.I.E.E., "Pneumatic Conveying Plants, with special reference to the Transport of Grain."

CANTOR LECTURES.

Monday evenings, at 8 p.m. :—

CHARLES FREDERICK CROSS, B.Sc., F.R.S., F.C.S., "Recent Research in Cellulose Industry." Three Lectures.

Syllabus.

LECTURE III.—MARCH 1.—*Cellulose and Derivatives.* Nitrates—Acetates—Progress of research and industry—Specific volumes of cellulose and hydrates—Data of fundamental importance, scientific and industrial—The problems of constitution.

WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.

May 3, 10, 17.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 1...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. C. F. Cross, "Recent Researches in the Cellulose Industry." (Lecture III.)

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Rev. Professor A. S. Geden, "Metaphor and Simile in the Fourth Gospel."

Farmers' Club, at the Surveyors' Institution, 12, Great George-street, S.W., 4 p.m. Mr. A. Amos, "Silos and Ensilage."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Society of, at the Geological Society, Burlington House, W., 5 p.m. Mr. R. H. Cunningham, "Some Engineering Work done by the 277th Railway Company (R.E.) in France and Belgium during the War."

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. (Joint meeting with the Faraday Society.) 1. Messrs. T. M. Lowry and F. C. Hemmings, "The Properties of Powders." 2. Messrs. T. M. Lowry and S. Wilding, "The Setting of Dental Cements."

Geographical Society, 135, New Bond-street, W., 8.30 p.m. Lieutenant E. W. P. Chinnery, "The Opening of New Territories in Papua."

TUESDAY, MARCH 2...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Colonial Section.) Mr. G. F. Scott Elliot, "Trade Routes for the Empire in Africa."

University of London, School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Mr. A. D. Innes, "The Mogul Period in the History of India." (Lecture IV.)

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. Keith, "British Ethnology: the Invaders of England." (Lecture I.)

Alpine Club, 23, Savile-row, W., 8.30 p.m.

Röntgen Society, at the Royal Society of Medicine, 1, Wimpole-street, W., 8 p.m. Professor W. H. Bragg, "Analysis of X-Rays." (Silvanus Thompson Lecture.)

United Service Institution, Whitehall, S.W., 3 p.m. Anniversary Meeting.

WEDNESDAY, MARCH 3...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. W. J. Garnett, "Mongolia from the Commercial Point of View."

Aeronautical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Professor B. M. Jones, "Flying over Clouds in relation to Commercial Aeronautics."

Sanitary Engineers, 296, Vauxhall Bridge-road, S.W., 8 p.m. Captain R. L. Reiss, "Housing and Town-planning in Greater London."

Industrial League and Council, Central Hall, Westminster, S.W., 7.30 p.m. Mr. H. Atkinson, "Economic Production and Prevention of Waste."

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Mr. C. A. Mitchell, "The Detection of Fingerprints on Documents." 2. Mr. C. J. Ward, "Photo-micrography with simple apparatus." 3. Mr. R. V. Wadsworth, "Note on the Solubilities of Theobromine."

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. M. C. Burkitt, "Some Unpublished prehistoric Rock-engravings from Russia."

Automobile Engineers, Institution of, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. Mr. P. J. Worsley, "Gears and Gear Cutting."

THURSDAY, MARCH 4...Royal Society, Burlington House, W., 4.30 p.m.

Linnean Society, Burlington House, W., 5 p.m.

Chemical Society, Burlington House, W., 8 p.m. Lecture by Mr. J. C. Burnham.

Royal Institution, Albemarle-street, W., 3 p.m. Lieutenant-Colonel E. Gold, "The Upper Air—Modern Methods of Investigation and their Application in the War." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Dr. T. M. Legge, "Guilds, Factories and Art."

FRIDAY, MARCH 5...Technical Inspection Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.30 p.m. Mr. W. L. Baillie, "Sampling: Some Problems and Fallacies."

Royal Institution, Albemarle-street, W., 9 p.m. Hon. J. W. Fortescue, "Military History."

University of London, University College, Gower-street, W.C., 5 p.m. Dr. T. Borenius, "Mediæval Art." (Lecture VIII.)

Philological Society, University College, Gower-street, W.C., 8 p.m. Mr. A. C. Wood, "Leicestershire Place Names."

Concrete Institute, 296, Vauxhall-bridge-road, S.W., 6 p.m. Mr. E. S. Andrews, "Some Properties of Steel."

SATURDAY, MARCH 6...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Positive Rays." (Lecture III.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

WEDNESDAY, MARCH 10th, at 4.30 p.m. (Ordinary Meeting.) H. M. THORNTON, "Gas in relation to Industrial Production and National Economy." SIR ROBERT A. HADFIELD, Bt., D.Sc., F.R.S., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, March 1st, Mr. CHARLES FREDERICK CROSS, B.Sc., F.R.S., delivered the third and final lecture of his course on "Recent Research in Cellulose Industry."

On the motion of the Chairman, Mr. E. C. DE SEGUNDO, A.M.Inst.C.E., M.I.Mech.E., a cordial vote of thanks was accorded to Mr. Cross for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

COLONIAL SECTION.

TUESDAY, MARCH 2nd; COLONEL SIR THOMAS H. HOLDICH, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., in the chair. A paper on "Trade Routes for the Empire in Africa" was read by Mr. G. F. SCOTT ELLIOT, M.A., B.Sc., F.R.G.S.

The paper and discussion will be published in a subsequent number of the *Journal.*

TWELFTH ORDINARY MEETING.

WEDNESDAY, MARCH 3rd; BRIGADIER-GENERAL SIR PERCY MOLESWORTH SYKES, K.C.I.E., C.B., C.M.G., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Crook, Charles W., B.A., B.Sc., London.
Ford-Moore, Lieut.-Colonel A. P., London.
Frazer, E. D., London.
Hough, Lynn Harold, Evanston, Illinois, U.S.A.
Howes, George Henry, Wallington, Surrey.
Parnell, Edward, Sarawak, Borneo.
Richards, Herbert Edward, Marlow.
Tonamy, Chika Hira, Fushimi, Kyoto, Japan.
White, Edmond Aungor, Port Kembla, New South Wales, Australia.

The following candidates were balloted for and duly elected Fellows of the Society:—

Brunyate, Sir James Bennett, K.C.S.I., C.I.E., London.
Dongarsingh, Ramsingh, London.
Hunt, J. H., Dayton, Ohio, U.S.A.
Hutchinson, Lieut.-Colonel Thomas Massie, D.S.O., O.B.E., British Troops in France.
Layton, Gordon Shakespear, Bury St. Edmunds.
Mackley, Edward N., Gateshead-on-Tyne.
Needler, F., Hull.
Nelson, Amos, J.P., Thornton-in-Craven, near Skipton.
Parsons, Lieut. Percival A., A.I.F., London.
Peto, William, M.I.E.E., London.

A paper on "Mongolia from the Commercial Point of View" was read by Mr. WILLIAM JAMES GARNETT, First Secretary, H.B.M. Diplomatic Service.

The paper and discussion will be published in a subsequent number of the *Journal.*

EXAMINATIONS.

The number of entries received for the first examinations of this year, which commence on March 22nd, is 17,671. This is an increase of 5,709 on the corresponding examinations of 1919, when 11,962 entries were received.

The second series commences on May 10th, and the last day for receiving entries is April 12th.

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1920 early in May next, and they therefore invite Fellows of the Society to forward to the Secretary on or before Saturday, March 27th, the names of such men of high distinction as they may think

worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce," and has been awarded as follows in previous years :—

1864, Sir Rowland Hill, K.C.B., F.R.S.
1865, His Imperial Majesty, Napoleon III.
1866, Michael Faraday, D.C.L., F.R.S.
1867, Sir W. Fothergill Cooke and Sir Charles Wheatstone, F.R.S.
1868, Sir Joseph Whitworth, LL.D., F.R.S.
1869, Baron Justus von Liebig.
1870, Vicomte Ferdinand de Lesseps, Hon. G.C.S.I.
1871, Sir Henry Cole, K.C.B.
1872, Sir Henry Bessemer, F.R.S.
1873, Michel Eugène Chevreul.
1874, Sir C. W. Siemens, D.C.L., F.R.S.
1875, Michel Chevalier.
1876, Sir George B. Airy, K.C.B., F.R.S.
1877, Jean Baptiste Dumas.
1878, Sir Wm. G. Armstrong (afterwards Lord Armstrong), C.B., D.C.L., F.R.S.
1879, Sir William Thomson (afterwards Lord Kelvin), O.M., LL.D., D.C.L., F.R.S.
1880, James Prescott Joule, LL.D., D.C.L., F.R.S.
1881, Professor August Wilhelm Hofmann, M.D., LL.D., F.R.S.
1882, Louis Pasteur.
1883, Sir Joseph Dalton Hooker, K.C.S.I., C.B., M.D., D.C.L., LL.D., F.R.S.
1884, Captain James Buchanan Eads.
1885, Sir Henry Doulton.
1886, Samuel Cunliffe Lister (afterwards Lord Masham).
1887, Her Majesty Queen Victoria.
1888, Professor Hermann Louis Helmholtz.
1889, John Percy, LL.D., F.R.S.
1890, Sir William Henry Perkin, F.R.S.
1891, Sir Frederick Abel, Bt., G.C.V.O., K.C.B., D.C.L., D.Sc., F.R.S.
1892, Thomas Alva Edison.
1893, Sir John Bennet Lawes, Bt., F.R.S., and Sir Henry Gilbert, Ph.D., F.R.S.
1894, Sir Joseph (afterwards Lord) Lister, F.R.S.
1895, Sir Isaac Lowthian Bell, Bt., F.R.S.
1896, Professor David Edward Hughes, F.R.S.
1897, George James Symons, F.R.S.
1898, Professor Robert Wilhelm Bunsen, M.D.
1899, Sir William Crookes, O.M., F.R.S.
1900, Henry Wilde, F.R.S.
1901, His Majesty King Edward VII.
1902, Professor Alexander Graham Bell.
1903, Sir Charles Augustus Hartley, K.C.M.G.
1904, Walter Crane.
1905, Lord Rayleigh, O.M., D.C.L., Sc.D., F.R.S,
1906, Sir Joseph Wilson Swan, M.A., D.Sc., F.R.S.
1907, The Earl of Cromer, O.M., G.C.B., G.C.M.G., K.C.S.I., C.I.E.
1908, Sir James Dewar, M.A., D.Sc., LL.D., F.R.S.
1909, Sir Andrew Noble, K.C.B., D.Sc., D.C.L., F.R.S.
1910, Madame Curie.
1911, The Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., D.Sc., F.R.S.
1912, The Right Hon. Lord Strathcona and Mount Royal, G.C.M.G., G.C.V.O., LL.D., D.C.L., F.R.S.
1913, His Majesty King George V.
1914, Chevalier Guglielmo Marconi, G.C.V.O., LL.D., D.Sc.
1915, Sir Joseph John Thomson, O.M., D.Sc., LL.D., F.R.S.
1916, Professor Elias Metchnikoff.
1917, Orville Wright.
1918, Sir Richard Tetley Glazebrook, C.B., Sc.D., F.R.S.
1919, Sir Oliver Joseph Lodge, D.Sc., LL.D., F.R.S.

PROCEEDINGS OF THE SOCIETY.

CONFERENCE ON HOUSE FURNISHINGS.

A Conference of Manufacturers and Distributors of House Furnishings, and of others specially interested in the subject, called by the Council of the Society, was held in connection with the Ideal Home Exhibition at Olympia on Thursday, February 19th, 1920, The Right Hon. Sir Auckland Geddes, K.C.B., M.P., President of the Board of Trade, in the chair.

The Chairman, in opening the Conference, said : Ladies and Gentlemen,—There is, I think, at all events one remark that one can make in these days without being contradicted by somebody who hears it, namely, that none of us like very much the present high cost of living. That means that if we wish to get rid of the high cost of living we have to develop the export trade on a far greater scale than we have so far achieved since the war. If we had the old pre-war scale with the present values I think the position would be very satisfactory ; but, as a matter of fact, we have not got the pre-war scale, and during the war we have been out of many of our markets overseas, with the result that those markets have—in part, at least—been occupied by our competitors. I hear from many of these markets the experience of the buyers of the goods which they have received from other countries, and that experience, broadly, is this—the goods which they are getting are quite good for the purpose when they get them, but they do not last so long as British goods. It is essential, therefore, that if we are to recapture those markets the whole quality of the goods which we send overseas should be better—if we can achieve that—than the goods despatched by any of our

competitors. Clearly the goods have to be in large volume, and that means quantity production. But we have to combine with that quantity production real quality in the goods themselves, and absolute fitness for the purpose for which they are intended. Not only have we got to get those qualities into the goods, but as a nation we have to produce goods which are pleasing in appearance and satisfactory from every point of view. It, therefore, is absolutely essential for us at the present time to combine all our forces—not only for the sake of our own homes directly, and for the sake of the articles which we ourselves use—but also for the sake of our export trade, upon which our comfort, our wealth, and the cost of living, so intimately and directly depend. It is, therefore, with the very greatest possible pleasure that I, as President of the Board of Trade, am here this afternoon at this Conference. We hope for great things from such conferences as these. We know the admirable work that has been done by the Royal Society of Arts now for many years. We have great hopes that the British Institute of Industrial Art will bring the craftsman, the designer, and the manufacturer together, and that the combined efforts of all our forces will have the result of placing us in a position in which we shall clearly be recognised in all the markets of the world as the leaders in intrinsic quality and the leaders in design. If by any chance we were to be driven out of our overseas markets we should, of course, be in a deplorable condition in a country such as this, where we do not produce enough food from our own soil to feed ourselves. One may, therefore, without exaggeration say that the sort of work that we are engaged upon this afternoon is of the highest national importance. Nothing could be more important than the achievement of the greatest efficiency for all our industries and for all our manufactures. I will not detain you any longer, but will now call upon Sir Henry Wood to address you.

Sir Henry Trueman Wood (Chairman of the Council): Ladies and Gentlemen,—The President of the Board of Trade has set us an admirable example in the brevity of his speech, and the amount which he crowded into a very few words, although I must confess myself disappointed that we did not hear more from so great an authority. I think my chief duty is to thank him, on behalf of the Council of the Royal Society of Arts, for lending his personal influence and the influence of his great Department to the movement which the Society is now doing its best to promote. But I should like, if you will bear with me, to say a few words about the work the Society has done and the reasons why it hopes to do more in the future. When the Society was first started in the middle of the eighteenth century the very first thing it did was to offer, amongst its other prizes, certain special awards for industrial art, and to lay especial stress upon the necessity of design in all those trades and industries which depend in any way upon ornament or decoration. The middle of the eighteenth century was not a favourable era for art in any form, especially for industrial art, and the Society of Arts was therefore like the voice of one crying in the wilderness. The public cared very little for applied art, and as a result the Society, following the direction of least resistance, drifted away to the encouragement of art pure and simple. For many years before the foundation of the Royal Academy, and until the Academy Schools obtained their deserved reputation, the Society of Arts was the one institution in England which promoted art education. For years it carried that on, though it never neglected its original and primary duty of the application of art to industry. I will not trouble you with the efforts it made in the first hundred years of its existence, but I will just remind you that one of the first things that Prince Albert, the Prince Consort, did when he became President of the Society was to tell a deputation from the Society that the most useful thing it could do would be to promote the application of the arts to industrial purposes. The immediate outcome of that suggestion was that a great many special prizes were offered and awarded for designs suitable for practical application, and the Society organised some very successful exhibitions, devoted entirely to ornamental manufactures. The ultimate outcome of the Prince's remarks was the great Exhibition of 1851, which, amongst all its other results, had a very remarkable effect upon the artistic manufactures of this country. As regards the production of furniture, I think the chief result was that our manufacturers produced a class of furniture of the very highest excellence, although it was distinctly deficient in original design. We never had a good British school of applied art, but we did succeed in producing admirable manufactures. One interesting evidence of this was that when our furniture manufacturers exhibited at Philadelphia in 1877, an enormous effect was produced on the manufacture of furniture in the United States, and the ultimate result was the production of a very large amount of excellent and very moderately-priced furniture by the application of machinery to the industry. I will not refer further to that point, but I should like to mention the work which the Society did for some ten years in the 1860's and 1870's by offering considerable prizes to art workmen. They offered amounts of about £600 a year, and they awarded prizes of about half that amount. A great deal of useful work was done, but I must say that the chief obstacle our predecessors found was the lack of any encouragement on the part of employers. The employers at that time were extremely reluctant to see the names of their workmen on the goods instead of the names of the manufacturers. I mention this fact because I believe that that feeling is not wholly extinct, and because I believe it is one which ought to be extinct, and I hope it will be before long. I will not trouble you by giving an account of what the Society has done during its existence—it would take too long

and it would embrace too much ancient history; but I can assure you that during the 150 years of its existence this old Society has done a great deal for the application of art to industry, and what I want to say now is that it is willing to do as much in the future. The Society is ready to place at the service of those industries where it may be useful its very widespread organisation and its very considerable influence. It hopes that the calling of this Conference together may lead to the holding of other meetings of employers and distributors in the particular industries in which you gentlemen are mainly interested, and in others also, and that the result may be the improvement of the articles produced and also an improvement in the economy of production.

We should remember that it is better for any trade to co-operate harmoniously in competition with foreign rivals rather than to encourage individual rivalry and competition among manufacturers. This is one of the objects of the Department of Industrial Research, in encouraging the formation of industrial associations in which rivals in trade are co-operating for the benefit of their trade, rather than working for what they consider to be their individual interests I hope that some such result may come from those conferences which will be the outcome of the present meeting.

Sir Frank Baines, C.B.E., M.V.O. (Principal Architect of H.M. Office of Works): Mr. Chairman, Ladies and Gentlemen,—I consider it is a very great honour to be associated at this Conference with the principles which I believe we all have at heart, namely, the desire to improve the standard of design and the method of production of the various articles utilised throughout the whole sphere of the building of houses. I think it is a very happy augury that this meeting has been called together by the Royal Society of Arts. I was going to refer to the history of the Society, but that has been done by the previous speaker, and I will therefore only raise one or two points which I think are of moment. For a period of 150 years the activities of the Society have been very considerable. During that time they have always been identified with the encouragement of arts, manufactures and commerce. The point I wish to make about the Royal Society of Arts was not made by the previous speaker, namely, that it was a private venture entirely supported and carried on by private funds without any assistance from Government. That, I think, is a point of very hopeful augury, and it shows what, unfortunately, we poor Government officials feel to-day—that institutions or movements promoted by Government are not of necessity the only movements which carry forward great ideas and give big results.

In its early days the Society of Arts gave premiums for drawing, and it awarded prizes for designs for weavers, calico printers, cabinet makers, and coach builders; and it also gave prizes to the manufacturers of iron, brass, china and earthenware goods. There, in my opinion, it was undoubtedly carrying out the direct idea which we have at heart to-day, namely, the material improvement of the general manufactures of this country; and it is a very happy augury to-day that we find this great Society, with its magnificent history, renewing its efforts to promote the applied arts of this country.

One recognises the absolute necessity of organised and sustained effort to improve the standard of industrial design, and we are called together to consider that problem to-day, and to review what in our opinion is tending towards assistance in that way and what is acting against it. To deal with the question thoroughly, I should like to obtain first of all a description of what an æsthetic standard is. The safest course to follow is to say that we will recognise the standard laid down by men of culture, men of knowledge, and men of training, and I think therefore what we should ask for is some scheme which will produce men of that calibre. Take the influence of the æsthetic qualities which we see so clearly in many of the productions of French applied art. There a point arises which I wish to bring very definitely before the manufacturers who are present to-day, namely, the paying quality of the æsthetic side of French products. I have met that aspect of the question all over the world; I have met it, unfortunately, in England, when, as a public official, I have been compelled to go to France for certain articles which I could not procure in this country. Does not that show that, once the æsthetic side of design, of standard of form, or standard of colour, is considered in the production of articles of utilisation in public buildings and houses, it is a very large step towards a considerable increase in the economic value of the goods, the extension of the market for the goods, and the establishment of a reputation which has a very high money value? We are often met by the answer of skilful business men: "We are interested in your ideas, but will they pay?" What I want to point out to-day is that they probably will. Certainly in the case of France they have paid, and in the case of England they have paid, as we realise when we think of the products of men like Josiah Wedgwood, and they will continue to pay in the future.

Then I think we must glance at what was the effect of the foundation of the Royal Academy in 1768. I think we can hardly claim that its institution had a material influence on industrial design. It has had a vast influence, undoubtedly, on the fine arts, but I see little sign of its influence on the applied arts. There is another body which has been formed recently, called the Design and Industries Association. That is a new Association, which has very noble

ideals, but I should like to ask whether any of the gentlemen in this room have ever gone to that Association and asked for its assistance and advice and taken its suggestions as to how they should deal with the problem of the design of the commodities which they are producing. I do not say that in any sense as reflecting upon the Association in question, but I say it as illustrating the fact that the associations and organisations available to deal with the objects we have at heart are not getting at the manufacturer. The Design and Industries Association is very modern; it accepts the application of modern machinery to manufactures and the possibility of utilising the highest principles of design in the manufacture of goods produced in bulk by machinery. That is a great advance, because so many artists and designers in the past have said: "We will not deal with goods which are produced by machinery; we will not soil our hands with them." That has been the great argument of the designer, and we have got to get over it; and I am perfectly certain, knowing the history of the Royal Society of Arts, that we shall never have cause to complain of it in that particular. Machinery has come to stay. Bulk production is the essence of our being, as our Chairman has pointed out to-day, more so now, perhaps, than ever. Therefore we have got to accept in principle that the standards of design and the suggestions which are made for increasing and altering those standards shall be applied to methods of manufacture to-day necessitated by the bulk production under which we live.

Then we have the Royal College of Art, which is a great institution; but here, again, its influence in relation to the applied arts has been meagre. It has not, in my opinion, utilised the great lessons which are almost at its elbow in that beautiful museum full of all sorts of objects and magnificent designs which directly deal with the question we have at heart. I feel that the criticism of the Royal College of Art is really contained in the report of the Departmental Committee which was appointed to consider its work. The following facts from that report are illuminating: 459 students went through the College. Of that number, 126 took to teaching, and only 32 took to practical design—roughly 6 or 7 per cent. of the whole; and if we tried to ascertain where that 6 or 7 per cent. are at this moment I do not know where we should find them. I am very certain that we should not find them helping the great manufacturers to improve the standard of industrial design. That rather shows us again that the work of the Royal College of Art, good as it is, is not assisting in the way wanted at the present moment. I hope it is not thought that I am reflecting in any way upon the great work of that College. I am simply pointing out that we cannot look to it to give us what we are aiming at here to-day. I feel that we have to strike out on new lines if we are to make history with regard to industrial design in this country.

The same criticisms which I have addressed to the Royal College of Art may be applied to the art schools generally. Students are undoubtedly not equipped for the business of taste in industrial design, and taste is a business in industrial design. It is not a question of pure initiative without training, without exact knowledge; it is a real business which has got to be learned like every other business. But, unfortunately, students are not learning the business of taste, and therefore we have to consider what methods we can propose and what courses of action are open to us to utilise that fine material which is going through the art schools year after year and not working on the problem with which we are dealing. The student has too often a contempt for tradition, and, unfortunately, he will not acknowledge the pure discipline of style. We are tainted with that practically universally in art matters to-day. A person who is not very far from me at this moment actually stated a point which I am now trying to bring out—namely, that it is vitally necessary to have originality in design. I agree, but I consider it even more vitally necessary to have a great tradition in design, a great knowledge of the historical standards of the past. I feel that an historical knowledge of style and an absolute grip upon the whole history of this country in regard to industrial design is far more essential than the originality which is called for as the first quality in students. After all, bearing in mind that ours is a fairly old country and that it is full of magnificent buildings of all periods and styles, and that our pictures, furniture, and Sheffield plate are part of the country, why should we discard them all and say: "We want to be original; we want new art; we want the individual man who produces what is in his brain, and we do not want what has been produced by the great men in the past"? I am sure that in that direction failure lies.

Now we come to the Arts and Crafts movement. I do not know what I am to say about that without raising a great deal of criticism. The very phrase brings up to me appalling pictures. I have bitterly suffered from that movement. I remember when I was quite a young man having to sit upon carved chairs, the seats of which were uncomfortably decorated with Tudor roses. Further, I remember being at dinner and trying to cut the ordinary beef, which in those days was much more tender than it is to-day, and failing because I had an instrument which was a production of the Arts and Crafts movement. Again, I have seen pewter plaques on the ceiling through which the wires were suspended for the electric light lamps. Now pewter is a metal which flows rather readily, and after a few minutes those plaques looked as though they had been knocked

about by all the children of the household. That is my personal experience of the Arts and Crafts movement, which may perhaps be a very unfortunate one.

I feel that we shall have to discard this movement for increasing the activity of industrial design. We have to go hand in hand with you hard-headed manufacturers, you men who produce the goods and who ask us awkward questions.

What have the Government done? Have they helped us in this matter? Are they moving on the lines which we have at heart? Do they show any signs of activity which will really give us a vast improvement in industrial design? Our Chairman has told us in his opening remarks how important it is to increase our export trade, not only in bulk but in quality. I say that that increase in quality can only come about by carrying forward the principles of bettering the design and standards under which articles are produced. What have the Government done? I am a Government official and therefore naturally I shall try to make as good a case as possible for them, but I am afraid I shall fail. As far as I can understand, the Government have subsidised schools of practical art. I have tried to get a definite record of what the accomplishment of these schools has been, but there again I have failed, and I can find very little sign of any influence of those schools promoted by the Government. The Government have also awarded medals and diplomas, but when I investigate the whole matter and ask what the result is I become depressed..

What have the manufacturers and distributors done? These are the men who say: "We are perfectly happy; we are delivering the goods. We can make what we like and sell what we make." They are lucky fellows, and they will be lucky for the next two or three years. After that I hope they will be a bit unlucky, because that is our only hope. What has the manufacturer done? All I can do is to go to his catalogues. I have a room full of them which I have to look through occasionally, and a more abominable list of examples I do not think it is possible to conceive. There is hardly a redeeming feature in them. The only thing that the manufacturer does in regard to his catalogues is to make up for quality by quantity. That is his standard. This matter is important and serious, and I have not said what I have said about the manufacturer without cause. If any manufacturer here has a grievance against me, let him come to my office and I am sure he will say worse things about these catalogues than I have done. My method will be to show him what the other fellow has done, and then if the other fellow comes I will show him what the first man has done, and he will criticise, and I shall get agreement on that basis. But the manufacturer undoubtedly has neglected to improve his designs by the selection of innumerable old examples which exist from the seventeenth and eighteenth centuries. He simply says: "The public want something new; I think this will fetch them." Where he gets his designs from I do not know. I think we can fairly come to the conclusion that, if the societies and institutions and the Government have failed, the manufacturer has also failed, and he is failing to-day. But he is such a good fellow that we cannot let him go without a tear, and we hope that our tears and our efforts for his regeneration will spur him to make an effort to improve and to raise the standard of articles which he produces. Another great fault of the manufacturer is this. He will produce a certain article—for instance, fire-grates. He will go to one man to produce the fire front; he will go to another man to produce the fender; he will go to a third to produce the coal scuttle, and so on; and in that way you get a most glorious heterogeneous collection when you bring them together in a room. We have the misfortune to live with them, and we are here to-day to lead the revolt against life under that standard. We think of the exquisite patterns of Chambers and the Adams, and the early grate-fronts produced by the Carron Company, and we compare those things with what we have got to-day. I dare say every one of us is familiar with the patterned oilcloth which is one of the abominations of domestic life. There, again, the manufacturer may say: "This is the fault of the designer." I say: "You have chosen the wrong designer." It may be that the designer has been wrong, because the designer in most cases will very rarely rule himself out and say: "You do not want design there; you want plain colour and plain surfaces." But even then the manufacturer has not been able to get rid of the designer and do away with those patterned oilcloths which are a monument of British philistinism throughout the world. Take, again, the *repoussé* copper curbs and hearth furniture that we see; they are the most appalling things, and one meets them everywhere. The manufacturer says: "We are doing very well on them, and we do not want any interference." What we say is this: "We want you to do well; you are assisting the country by your progress, and therefore your progress is what we have at heart; but we suggest to you that you can get that same progress better by raising the standards and by altering the products which you have made in the past."

Is there no credit side to this rather unhappy and pessimistic account? I hope there is. We have the new British Institute of Industrial Art. I feel it has possibly a great future before it, and the Chairman could doubtless tell us a great deal about the proposals which he is putting forward and considering for its extension and for the furtherance of its activities.

Then we have the Royal Society of Arts with us, and the incentive which has been given to the movement by the Society calling this Conference here to-day. In the past the Society has awarded prizes to Minton and Co. for pottery; Osler and Co. for glass; Woollams and Simpson for wallpapers; the Coalbrookdale Co. for iron castings; and Crossley for carpets. These firms have produced fine articles, and we know perfectly well that they can produce them again. We also know that the Society helped in the production of these fine articles. We want them to help again. That is an undoubted example of the influence of the Society directly upon the lines which we have at heart. But there is one point that I want to warn the Society about, and that is that, curiously enough, the standard of industrial design has consistently declined during the period which closely corresponds with the activities of the Society. For the last 150 years the standard of industrial design has fallen. The causes of the decline, however, are deeper than anything to do with this Society. They are the decay of handicraft consequent upon the introduction of machinery, the amazing commercial expansion which is one of the most astounding factors of the commercial history of the world, the industrial revolution from 1760 to 1830, and the vast activity which shows such little signs of cessation to-day. The manufacturers for the last 150 years have been engrossed in this tremendous commercial expansion, to the exclusion, as a rule, of purely artistic considerations; but one of the greatest items on the credit side, in my opinion, comes from the manufacturers themselves. One of the most hopeful signs is to note the work of men like Josiah Wedgwood and Matthew Boulton, the founder of the famous Soho works at Birmingham. They produced work of an extraordinarily high standard—work which at that day was produced by means of mass production, and yet which came up to the very highest standard of artistic excellence as well as workmanship. British manufacturers have themselves given us the keynote as to what can be done, and all we say is: "Do it again." Consider the great potter Wedgwood and what he did; he developed a business of enormous magnitude which has been continuously increasing. He added vast industries to the resources of the country; he materially increased our foreign trade, and he also produced works of pure excellence and design unparalleled in the history of British commercial production.

I suppose we ought to refer to the influence of Ruskin on the movement. Although it is very difficult to trace his influence on the actual production of artistic commodities of British manufacture, there is not the slightest doubt that it was very great. He had the enthusiasm of a man of genius, and in his writings he consistently aimed at the best. But the man who did more than Ruskin was William Morris. There we have a man who showed tremendous activity in stimulating and fostering a dozen industries, a man of overpowering individuality who achieved impossibilities. Other names might be mentioned, such as the brothers Adam and Chambers. But, generally speaking, reviewing the whole position to-day, I think we may say with absolute fairness that the condition of industrial art is chaotic and lamentable in the extreme, and, what is more lamentable still, there seems to be little desire to improve it.

This brief review seems to me to show that manufacturers, the Government, and the public, are united in a sort of tripartite blame, and that being so it is no good for us to fold our hands and say: "We are all bad fellows; let us remain bad," and therefore we have to form a mutual encouragement society. The manufacturers' reply will be: "The Government have failed to assist us. We are simply asked to carry out the requirements of the public. The public will have what they want. Our success is due to the fact that we give it to them." I think that argument wants a lot of examination. I have been told by someone that it is very dangerous in addressing manufacturers to deal with the word "art." He said: "The word 'art' is anathema to the manufacturer; I should keep off it if I were you." I do not believe the manufacturer is quite as bad as that. His pocket is too well lined to fear any of my criticism, but I do feel that if we approach him and assure him that art is nothing but a standard of pattern, of form and of colour, and that it is an offshoot of science, he will take a different view. If we plunge into the principles which direct æsthetics we shall find that they are resolvable on a scientific basis. It seems to me that, if it was looked at from the point of view of being an ordinary everyday proposition to set up a definite standard of pattern *qua* quality only, the manufacturer would not be so nervous of the word "art" in industrial affairs. The word "science" does not seem to frighten trade or the Government. The Government has done great things for science and industry to-day. It has promoted a Committee of Scientific and Industrial Research, which is prepared to appoint special committees to go into any question of science raised by any trade of the country. It has at its disposal that great educational institution, the National Physical Laboratory, and it sends there for examination and for research any problem which trade and commerce may address to it. Here we have an example of the way in which the Government and trade generally appreciate the importance of co-ordinating under one body science as applied to trade. Is it not necessary, therefore, to consider the advisability of promoting such a co-ordinating authority with regard to art in trade and industry? Whether it should be promoted under Government auspices or not is a doubtful question—I am not prepared to

say. I know the suspicion which seems to exist of late with regard to Government movements on the part of industry and trade. Undoubtedly that is justified on many lines. Bureaucracy is walking very tenderly to-day.

What is the real solution? Is it in a Ministry of Fine Arts? If it could act on the lines of Colbert, the great Minister of Louis XIV., a Ministry of Fine Arts would do invaluable work for the nation, but I am rather inclined to think that such an organisation is not suited to us. In the next place, is the solution in intelligent Government support? I am sure the answer to that is in the negative. Is the solution in the extension of the powers of the British Institute of Industrial Art? That is a new body which it may be will break new ground and make history. I hope that we shall see in that Institute a real attempt to deal with the problems which we are talking about to-day. A question is whether the art schools can be brought into closer touch with employers of labour in industry, whether the cure is in a new system of technical education, or whether reliance can be placed upon the new vigour of the Royal Society of Arts. Every effort will help, and we cannot afford in such a vast field to discard any influence which is working towards the end we have in view. I am inclined to think that the answer will be: "Manufacturer, heal thyself." He has done it in the past, and I am inclined to think he can do it again with regard to the standard of industrial design. My proposition, therefore, is rather on these lines: That the trade and society generally shall say: "This proposition is important to us and we are prepared to go into it ourselves. We will investigate it ourselves. We will see whether we cannot support our own movement and rejuvenate ourselves, as we have done in the past." That, I am inclined to think, may be the solution, and it is a solution which would be a very happy augury for the future, because it is on the direct lines of purely individualistic expansion of British trade generally.

I have been asked to move a resolution embodying more or less the principles which I have enunciated, and which may come out of the discussion that will now take place. For the purpose of offering some sort of sop to the meeting or some bone to gnaw at, I move this resolution, but I want it to be understood that it is not necessarily a definite one; it is subject to suggestion and argument on the part of any of those present. I move:—

"That this Conference expresses its appreciation of the efforts which are being made by the Royal Society of Arts and the British Institute of Industrial Art to extend the use of art in industry, and is of opinion that a small general committee should be formed, under the auspices of the Royal Society of Arts, containing representatives of the various trades concerned, to investigate further with a view to securing a concrete issue of the propaganda undertaken by the Society."

The Chairman: Ladies and Gentlemen,—I am sure we all feel there is plenty of matter to discuss—that there is not only one bone to gnaw at, but a handful of bones—in fact, I think there is a bone apiece all round. I hope that you will take part in the discussion on the resolution which has been moved by Sir Frank Baines. I am now going to ask you to excuse my further attendance at the meeting, as I have another important engagement to fulfil. I should like, before I go, to express my intense interest in what I have heard here to-day, and further to express the hope that out of this Conference some good will really come. I now ask Sir Frank Baines to take the chair.

Sir Henry Trueman Wood: Before Sir Auckland Geddes leaves, I am sure it would be your desire, ladies and gentlemen, to accord a hearty vote of thanks to him for presiding over the meeting.

The chair was then vacated by Sir Auckland Geddes and taken for the remainder of the meeting by Sir Frank Baines, C.B.E., M.V.O.

DISCUSSION.

Mr. Charles Tennyson, C.M.G. (Federation of British Industries), in opening the discussion, said he desired to confess at once that he represented a large organisation of manufacturers, and he said so without shame, because he thought the blame in the matter lay not with the manufacturers but with the public. The manufacturer was tied hand and foot by the public in two ways. First of all, the shares in manufacturing companies were held largely by the public; in the second place, the manufacturer had to persuade the public to buy his goods. It had been said that when the public was given a choice between a good thing and a bad thing it would choose the good. He regretted to say that that was not the fact. If it were, it would be necessary to postulate that the standard of taste of the manufacturers and designers was below the standard of taste of the public. So far as the manufacturers were concerned, he said nothing, but so far as the designers were concerned he thought that could hardly be maintained. Undoubtedly the great public bought the worst works of fine art, and, bearing that fact in mind, it could not be said that the public unerringly chose the good when it was given a choice. There was a public which chose the good, but it was a small one, and that public was faithful to high ideals. But a small public was of no use to the manufacturer who had to concern himself with bulk production, and that was the great problem the manufacturer was up against at the present time. There was one customer who could practically dictate the terms

upon which he would buy and who could order in bulk, namely, the Government, which Sir Frank Baines represented. He thought the Government might take a very useful step in the matter if it made it a part of its pronounced policy that it would only buy good designs, that it would take proper advice as to what were good designs, and that it would not mind paying a little more when it got them. The Government should so formulate its policy that it would enable manufacturers to make what the Government wanted in bulk, and if that were done he thought it would be a very long step in the right direction, and that the organisation which he had the honour to represent would co-operate in every way with the Government to further that end. The problem was a very new one. Design originally came out of craftsmanship, *i.e.* the man had his tools and his materials, and out of the use of those two things designs spread. At the present time, however, the machine had taken the place of the tool, and that could not be run without a huge organisation and a great many workers and directors. The problem at the present moment was how to get the craftsman's mind to operate with that machine, and so far as he could see there were only two ways of doing it. The first would probably be done if there was a great collective æsthetic spirit in the country. If the whole country knew what good design was and wanted it, that æsthetic spirit would operate on the machine and a new craftsmanship of machine would be obtained. But he was afraid that was 100 or 150 years off. The only other way in which it was possible to bring such a state of affairs about was if the manufacturers would take a leap in the dark, and, chancing whether they would sell their product, say: "This is a matter of art and of æsthetic quality in a special line; we do not understand it; we only know what we can sell; but we are told that for the good of the public we ought to do something better. We will go to those who understand it, and take their advice." If every manufacturer in a large way would try to get into touch with some artist of standing, originality and practical sense, and give him a fine position in his works, he thought some good would result. Every manufacturer should have an art director just as he had other kinds of directors. As an instance of that he thought it would be of interest if he stated that he was recently informed that in a large retail firm in New York the head window-dresser was paid the largest salary next to the managing director. That was the kind of position he would like to see an artist occupying in some of the factories of this country.

Mr. Marshall Roberts suggested that the Government should hold exhibitions every year at which the manufacturers, workers and artists could exhibit their wares, and, if necessary, sell them. At any rate, they should be well rewarded for having produced works of art in the way of furniture, carpets, and every other article that was required for the furnishing of an artistic home. If the Government held such an exhibition and offered substantial prizes, he felt quite confident that better taste in the British home would result.

Mr. H. E. West Taylor (Secretary, London Cabinet and Upholstery Trades Federation) said he was sure most of those present agreed with Mr. Tennyson's remark that it was utterly useless to blame the manufacturer. He did not know whether the Chairman remembered the class of song which was rather popular at the time when they were boys, but he recalled one song in particular by the late Corney Grain, about a little boy in a white surplice, one of the verses of which was :—

"And when he sang in choruses
His voice o'ertopped the rest,
Which was very inartistic,
But the public liked it best."

So far as he was concerned, that entirely summed up the difference between the Chairman and the organisation which he (Mr. Taylor) had the honour to represent. It was not the slightest use asking the manufacturers to lead the public. Manufacturers were far too busy with labour troubles, apart from anything else at the present moment, and with other matters which were loosely dealt with under the comprehensive title of "reconstruction," to educate the public. Manufacturers would supply what the public asked for if the public was taught to ask for the right thing. A very great number of cabinet shops in London, on behalf of which he had the honour to speak, employed very large staffs and very expensive designing departments, so that the accusation which had been made that manufacturers neglected that side of their business was entirely unfounded. A great deal had been heard about the British Institute of Industrial Art. As Secretary of the London Cabinet and Upholstery Trades Federation, representing the whole of the manufacturers of furniture in London, that Institute had never been brought officially before his notice, and if that was the case, how was it possible for manufacturers to take advantage of whatever facilities such institutes afforded? He maintained that if the Government desired co-operation between manufacturers and any particular institute, the first step that should be taken was to acquaint the associations of the manufacturers of the existence of such an institute, and afford the Federation the opportunity of expressing their opinion. He suggested that the proper method to adopt was for the Government to get into touch with the manufacturers through their associations, and to spend their time and money,

not in slanging the manufacturers but in educating the public.

Mr. S. D. Bianco, speaking as a cabinet maker, suggested to Sir Frank Baines that in looking at manufacturers' catalogues he must have noticed in recent years that great improvements had been made. Although the public perhaps had not asked for improvements, the manufacturers themselves had certainly improved their designs of late years, particularly since the time when Messrs. Waring came to London. That firm instituted one of the finest studios, and since that time the design and production of furniture in general had been greatly improved. All manufacturers could not hope to be Waring and Gillows, but, on the other hand, the manufacturers in general, whether in London or out of it, were engaged in producing what he called very creditable replicas of the old masters; in fact, in some cases some of their products were better than the old examples. The designers who had been trained in the various manufacturers' studios during the last ten or fifteen years were very smart men, and there were a number of excellent designers now coming along. So smart were they that the American retailers in particular came to this country and tempted them to go to America. That was particularly the case before the war, when some of their best men were induced to go to America by firms who did not mind paying any price in order to get the best brains. But a large number of excellent designers still remained in the country. Manufacturers were doing their very best at the present time, and had succeeded in bringing the furniture of this country out of that nasty period which used to be called Louis and Chippendale with a lot of icicles on it, and the vile old oak things that used to be seen in Wardour Street. All that had been killed, and even in the much-abused East End of London the Sheraton style—locally known as "Sheridan" style—had been killed, and they were now making Adam, Chippendale, and other good reproductions. He did not think the manufacturers deserved the scolding that had been given to them by Sir Frank Baines.

Major A. Longden, D.S.O. (Director of the British Institute of Industrial Art), in reply to Mr. West Taylor, said the reason the Institute had not come in touch with all the manufacturers was, first of all, that it only received its Articles of Association eight or nine days ago. Since then he had visited the trade in Manchester, Carlisle, Bridge of Allan, Stirling, Glasgow, Edinburgh, and Stoke-on-Trent, including that most excellent firm of Whittick and Reid, at Edinburgh. A finer firm of cabinet makers and manufacturers could not be found. They were turning out splendid trade productions, designed by Sir Robert Lorimer. Doubtless he would have the privilege of visiting all the manufacturers in time, as he did not intend to sit in an office during the period he held the post of Director, but it was very difficult for him to visit everybody. He suggested a better plan would be for the manufacturers to come and see him at 217, Knightsbridge, where the Institute would then place at their disposal all the information they required. The Institute would very much like to help in regard to the excellent remarks made by the last speaker about icicled Chippendale, and it was only through conferences such as the present one that it was possible for the Institute and the manufacturers to get into real touch with one another. The Institute hoped to be able to form some link which would be of use for the purpose of spreading information from abroad. Through a bureau of information the Institute was now getting from our consuls samples and photographs of the articles that would sell best abroad, and it was hoped to have not only an exhibition in London which would be open all the year round, but exhibitions in the provinces on the lines run so well by the Design and Industries Association. With regard to trade catalogues, which had been severely dealt with by Sir Frank Baines, the Institute was making collections of the best catalogues in the country, and they could be seen by all those manufacturers who cared to inspect them. He agreed in general with the statements the Chairman had made in that respect, but there were exceptions which held their own against any catalogues in the world. It was necessary, however, for a meeting such as the present to co-operate with the Institute if they were to help one another to bring about a better state of affairs. If the Institute could not give the manufacturers what they wanted at the moment, it was the Institute's business to get it, and that was his instruction to the officials who were in charge of what was called the Bureau of Information. The first exhibition of the Institute, which would be opened in May, would be of furniture, textiles and ceramics, and he had no doubt the manufacturers concerned would apply to him for further particulars of that exhibition.

Mr. E. J. Brown (of Messrs. W. Lamb and Co.) said there had been a good deal of abuse of manufacturers for the bad catalogues and bad furniture they produced, but the last speaker had said he had seen some fine furniture in Scotland. Those manufacturers who were engaged in his class of business required information in regard to well-designed articles, at a price which was not prohibitive, suitable for young people who were getting married at the present time. All the designs of Sir Robert Lorimer and all the scolding of manufacturers for the catalogues they produced would not meet that demand. The manufacturers he represented desired a lead as to the

way in which it was possible to do their present business—namely, how to manufacture furniture for the public on simple lines and in an artistic manner. They did not want to hear so much talk about artistic stuff; they wanted not so much talk but a little more "do." There should be more co-operation between all those concerned in order that good, strong, and well-made furniture of good design should be produced at a moderate figure, so that young people who wished to get married could do so.

MR. PERCY A. WELLS (Head of the Furnishing Department, Shoreditch Technical Institute) said he desired to ask whether it was the fault of the public or of the manufacturers that there was not a single cottage in the Ideal Homes Exhibition suited to the taste or to the purse of the cottager. The public were invited to go into artisans' cottages which were furnished with most expensive eighteenth-century furniture. In the cheapest cottage he saw a wardrobe standing on the landing priced at £20. In going into a seventeenth-century living room, however, the impression instantly produced was that of homely dignity and comfortable homeliness. He did not for one moment maintain that the furniture was suitable for modern requirements, but he hoped some endeavours would be made to get back to something of the simplicity and the homeliness of that furniture for the furniture of the new cottages. He suggested that architects who built cottages, particularly near to large centres of industry, might call together a committee of cabinet makers, ladies, and other people interested in the movement, and invite the local manufacturers to furnish a cottage with simple and cheap furniture which was pleasant to look at and fit for its purpose. Cheap articles need not be so atrociously ugly as they were at the present time. It was difficult to say whose fault that was, because there were so many people concerned, but he believed that if the public made up its mind on certain simple principles in buying furniture—for instance, that it should be fit for its purpose, that a sideboard should be a sideboard and not something with bits of carving and plate glass all over it—a practical step would be taken in the right direction. Moderately cheap furniture could be made which was pleasant to look at, and which was nevertheless substantial and sound, and there were plenty of designers who could design such furniture if the manufacturers would only pay them to do so.

MR. D. M. DAVIES inquired whether anybody in any other country in the world had ever seen furniture designed on such beautiful lines as English furniture, and whether any other country produced furniture of such simple and beautiful construction. Personally, he did not know of any other country where furniture was made in anything like the quantity or quality in which it was made in England. The whole world came to England for its furniture, although they had forests at their elbows. Nevertheless, they sent their timber to England and re-imported that timber in the manufactured state as furniture. That pointed to the fact that English manufacturers must give a certain amount of time to design alone. There were present at the meeting some of the leading manufacturers of furniture in England, whose designs were recognised throughout the world, and he did not think they could be improved upon. It was really only a question of providing cheaper lines of furniture of better design, and that was simply a question of price. So far as catalogues were concerned, it was almost an impossibility for a firm to catalogue the choicest of its designs, inasmuch as the majority of furniture made in high-class shops was repeated only once or twice. The design did not lend itself to being repeated over and over again, nor was it possible to sell large quantities of furniture designed on such high-class lines. If Sir Frank Baines would write to some of the English manufacturers and ask them for private photographs of their highest class furniture, he did not think he would be disappointed. He was very much afraid that the public, and probably foreign buyers, were educated by the catalogues that were published. That was rather foolish, inasmuch as no producer of first-class cabinet work in this country would dream of cataloguing all his designs. He would not pay a large sum of money for the brains of a good designer, and then give the benefit of them to the whole of his competitors. That was not business, nor was it reasonable.

ADMIRAL L. G. TUFNILL, C.M.G., said that, as an absolutely impartial and unbiased member of the public, who knew nothing whatever about the trade except that he occupied the unfortunate position of occasionally having to buy furniture, he desired to support the remarks made by Mr. Wells in regard to cottage furniture. He owned a few cottages and lived in the country, and was only too anxious, as he had always been, for the welfare of those who worked for him. It was altogether impossible and impracticable to put in a cottage the furniture seen at the present Exhibition. A great many improvements might be made. For instance, although furniture might be cheap it need not be repulsive, and many useful little details in connection with cottages not shown at the Exhibition might be incorporated with the greatest benefit. Many little economies could be introduced in connection, for instance, with fireplaces, which would make an enormous difference in the comfort and living of the occupiers of the cottages and smaller houses in England.

MR. JAMES SMELLIE said that to understand the difficulties of manufacturers in reference to design, it was important to realise how the trade was carried on. Some years ago he propounded a scheme which, it seemed to him, was as practical at the present moment as it was then. The furniture of a particular room was probably produced by five or six different manufacturers, and if it was desired that the furniture of a room should be properly designed it was necessary that a master designer should design all the furniture, separate firms, if necessary, making particular articles. If a Government department did the designing and left each manufacturer to deal with his own section, when the furniture dealer had to supply furniture for a complete room, although he bought the articles from half a dozen different manufacturers, the furniture would all be of the same design. The articles would also be produced at an economic price, and there was a reasonable chance of getting a house well furnished without having to pay an exorbitant sum. On the other hand, anybody who desired to furnish a room at the present time had to employ a special designer, and the goods were produced at a greatly increased cost. If a design could be fixed and the articles made at a reasonable price, the proposition would become a practical one; but at the present time too frequently goods were made in very small quantities. If the goods were produced in large quantities, the percentage of profit could be reduced. The first essential was to educate the salesman, who had a great deal of influence over the public. If the salesman was educated to understand the difference between goods that were well-made and well-designed and those that were not, he would have a great influence on the buyers, and struggling manufacturers who were trying to produce better designed goods would have a chance.

MR. H. T. KEMP suggested that the industry would be much improved if poor inventors were assisted by the Government, as they were by other Governments. In this case much better work would be done for the community, because, unfortunately, it was too often the case that it was useless for a man to have brains unless he also had money.

The resolution set forth on page 254 was then put and carried unanimously, and a vote of thanks having been accorded to Sir Frank Baines for his conduct in the chair, the Conference terminated.

A NEW ARABIAN RAILWAY.

A railway from Aden, the principal port in Arabia, to Lahej, the capital of the Abdali tribe in south-western Arabia, was opened last year. The line is about thirty miles in length, and is the development of a short military line built from Aden to Sheik Othman in 1915, to supply British forces operating from the latter place against the Turks. After the signing of the Armistice, and the surrender of the Turkish forces, the railway was continued to Lahej.

The line is a narrow-gauge one, the equipment being largely from the old Bombay, Baroda and Central India Railway. All the way from Aden to Lahej the track is laid over fairly even ground, and the elevation increases very gradually. There are no bridges and few culverts. To Sheik Othman the distance is about nine miles, and Lahej is about fifteen miles farther, over fairly level desert of shifting sand. Approaching Lahej, the sandy surface becomes harder, and there is extensive cultivation by irrigation through the use of the limited supply of water from the Tiban River, which comes down from the Yemen Mountains and divides five miles before it reaches Lahej. Dates, grains, melons, and vegetables are the principal crops in the Lahej delta.

In normal times Aden, where nothing grows, was able to draw some supplies of vegetables and other fresh foodstuffs from Lahej. These supplies then came in by camel caravan, but can now come in more cheaply and more quickly by the railway. Aden will thus benefit directly by having available a more plentiful supply of grain and other fresh foodstuffs.

Lahej has also been a centre for the collection of considerable quantities of goat and sheep skins, hides, and coffee, coming down by caravan from the fertile Yemen country to Aden for purchase by exporters. From Lahej to Aden the only method of transport was by camel caravan, and in the last normal trade year the Aden Port Trust statistics show that an average of nearly 500 camel loads of produce per day came into Aden by caravan. Some part of these loads came from the east, but a good share of them came in *viâ* Lahej. Over these same caravan routes there was exported annually from Aden to the interior, in normal trade years, practically 500,000 dollars' worth of cotton piece-goods, raw tobacco, spices and grains. The number of camel loads (a camel load averages round about 400 lb.) of exports is not ascertainable, but it was large, judging from the value of the goods carried.

Aden is the first of all Arabian ports, and is further important as a commercial centre for the collection and distribution of goods from and to the territories on both sides of the Red Sea and the Gulf of Aden. Owing to its superior advantages as a port it has long received a large share of the skins, hides, coffee, and other produce from the Yemen and other less important parts of the hinterland. The centre and capital of the rich and watered Yemen plateau is Sana, which is about 200 miles north of Aden. Trade by caravan between Sana and Aden is said to have existed for many centuries, but in recent years, when speed in getting products to the coast has become more essential, some of the caravans have changed over from the Aden route to Hodeida, a port north

of Aden, on the Red Sea, and about 150 miles from Sana.

Hodeida has been Turkish, and Aden has been and is British, and there has in recent years been much conjecture as to whether, by improving the former port and having better communication with the interior, it might not be possible to divert from Aden some of the business done by it with the Yemen. To this end a railway from Hodeida to Sana was begun in 1906 by European engineers, using Turkish capital. Only a few miles of track were laid when the work stopped, and great supplies of railway material which had been brought in have since lain rusting on the shore near Hodeida. The matter of a railway from Aden to Sana had often been talked of, but owing to the longer distance, as compared with Hodeida, and the possibly greater engineering difficulties when the mountains should be reached, no active steps to build such a line had been taken. As already stated, the necessities of war resulted in the beginning of the Aden-Lahej railway, and as the start has been made with thirty miles of track it may be possible to develop sufficient interest to continue for 170 miles into Sana.

According to a report by the United States Consul at Aden, from which the foregoing particulars have been extracted, the possibilities for profit in extending the railway on from Lahej into the Yemen Mountains, and possibly to Sana, would seem most promising. The Yemen plateau is well watered because of its altitude, and the soil is said to be fertile. This district produces the world's supply of genuine Mocha coffee, and many kinds of grain are successfully grown, while tobacco, indigo, cotton, fruits, and vegetables are also produced. Large herds and flocks of cattle, sheep, and goats are kept and supply an important quantity of hides. Mocha coffee, the skins known to the trade as mochas, and hides and skins from the Yemen would seem to be the most important products of commercial interest.

While the quantities of these products hitherto supplied have been considerable, they have naturally been limited by the difficulties of getting them to the coast for export, and by the further fact that the Arab farmer has had to devote much of his energy and attention to producing, as well, his own food supply. If he could get food from the outside, which would be feasible if a railway were built, he would have more time and energy to devote to producing greater quantities of the, to him, more profitable crop of fine Mocha coffee. He would incidentally want, and be able to buy, greater quantities of cotton piece-goods and other manufactures from the world markets. The above considerations suggest, briefly and generally, the possibilities offered to an extension of the Aden-Lahej railway to Sana; particularly as the Hodeida-Sana railway enterprise has for some years been abandoned, and is now obviously at a disadvantage as compared with the Aden-Sana projects, Hodeida having been seriously damaged by bombardment during the war.

Engineers connected with the Aden-Lahej railway say that from the engineering standpoint the construction of the line to a point fifty miles beyond Lahej would not present great difficulties, but that the remaining 120 miles to Sana, being through mountainous country, would undoubtedly present difficulties, although the route has not been surveyed. As the Yemen country is said by travellers to resemble mountainous Abyssinia in many ways, it is unlikely that the physical difficulties of building a railway through the mountains would vary greatly from those comparatively unimportant ones of the route over which has been built the Franco-Ethiopian railway from Jibouti to Adis Abeba, 500 miles in length.

UTILISATION OF FISH OFFAL IN BRITISH COLUMBIA.

A comparatively new industry has been established in British Columbia at Tucks Inlet, across the bay from Prince Rupert, in Osborne Cove. The company which established this industry is known as the Tucks Inlet By-Products Company, a Canadian organisation with a capital of 125,000 dollars, and with head offices in Vancouver.

The products of this concern are obtained entirely from fish offal. The company manufactures fish meal, which is a valuable fertilising ingredient, and fish oil, which is used in the manufacture of soap. In the opinion of the Company's manager, writes the United States Vice-Consul at Prince Rupert, this oil can be used in the manufacture of glycerine also. The offal is obtained from the various canning plants along the Skeena River and from the Prince Rupert fish-packing companies. This plant in reality serves a double purpose, inasmuch as it produces a marketable product of very considerable value from an otherwise worthless raw material, and at the same time disposes of offal that would be a nuisance in a community where fishing is the most important industry and canning establishments are so numerous.

The offal is collected from the various canning plants and packing houses and conveyed to the fertiliser plant. Upon arrival the offal is hoisted to the top of the factory to the storage hopper, from which it descends through the various cooking and crushing machines to the basement. This operation is repeated, and after the oil and moisture are extracted the residue constitutes meal ready to be used in fertilisers.

As the offal fats are contained in oil cells or tissues, the offal used for oil is heated or cooked in order to break up these cells. Then the moisture and oil are pressed out and separated and the oil refined.

The oil is placed in storage tanks at Prince Rupert and transported in tank cars *viâ* the Grand Trunk Pacific Railway. Fish meal is shipped by steamer direct from the plant. Both oil and meal are sent principally to the United States, the former to Chicago and vicinity, and the latter to Pacific coast ports. The meal is used principally in California and Hawaii.

NOTES ON BOOKS.

COTTON IN BRITISH WEST AFRICA. By N. M. Penzer, B.A., F.R.G.S., F.G.S. With an introduction by the Right Hon. the Viscount Milner, G.C.B., G.C.M.G. London: The Federation of British Industries. 5*s.* net.

The necessity for increasing the supply of cotton grown within the Empire is being recognised more clearly every day. America is using up her own crops at a rate that increases year by year, and Lancashire will have to look to all possible sources to secure the immense supplies that she needs. Comparatively little is known about West African cotton, and consequently this book, which contains, in a handy and comprehensive form, a great deal of information, should be of special interest to the cotton industry generally.

Section I. is devoted to a short historical sketch in which the industry is traced from earliest records up to date. Section II. deals with Nigeria. After a few general remarks, the methods of cultivation and varieties of cotton are described, with additional notes on the local industry, transport, and diseases and pests. The other British Colonies (Gold Coast, Sierra Leone, and Gambia), are treated in Section III. The cotton-growing in these colonies is, however, now reduced to a local industry. Section IV. describes cotton-growing in Togoland and the Cameroons, giving general and historical details, varieties of cotton, and statistics where available. Section V. deals with the Lake Chad District, chiefly from a point of view of the possibility of its development as a cotton-growing district. Section VI. is devoted to the future of cotton-growing in British East Africa, special emphasis being laid on the necessity for the further development of roads, railways, and agricultural departments.

General statistics and a bibliography complete the volume. The latter embraces the period between 1881 and 1920. It is arranged chronologically, and besides containing books on cotton-growing, has several references to works on spinning, weaving, etc.

THE TIMBER MERCHANT'S HANDBOOK. By Frank Tiffany. London: William Rider & Son, Ltd. 5*s.* net.

The first nine chapters of this book deal with the measures of timbers. In almost every trade there are confusing varieties of measures: for instance, a quarter of linseed from India, if Bombay shipped, is 416 lb.; if Calcutta shipped, is 410 lb.; if bought in Mark Lane, it is 496 lb., but if bought in cargo it is 492 lb. Wheat, again, is sold in Cambridge by the coomb, in Newcastle by the boll, in Doncaster by the load. Plums are sold in Worcestershire by the "pot" of 72 lb., in Middlesex and Kent by the half bushel, which is sometimes 28 lb. and sometimes 24 lb. In the case of apples one is supposed to get 40 lb. to the bushel, but with some kinds one gets more and with others less. One might multiply instances *ad nauseam*, but surely nowhere are the measures more confusing than in the timber trade. In softwoods we have the Petrograd Standard, which equals 165 cubic ft.; the Wyburg Standard of 180 cubic ft.; the Drontheim Standard of 198 cubic ft.; the Christiania Standard of 103⅛ cubic ft.; the Drammen Standard of 121½ cubic ft.; the London and Irish Standards of 270 cubic ft.; the Quebec Standard of 229⅙ cubic ft.; and the Riga Last of 80 cubic ft. Similar complications run through all the timber measures, and the novice will find in Mr. Tiffany's handbook a valuable clue to guide him through the labyrinth which without it must at first seem absolutely paralysing.

Part II. deals with the various kinds of woods; and here the author puts in a plea for precision of nomenclature. There is almost as great confusion in this respect as in the various systems of measures, and Mr. Tiffany refers to a Professor of Botany who includes as "Mahogany" the following woods: African Walnut, African Cedar, *Pterocarpus indicus*, Red Serayah, Camphor Wood, Teak and Sabicu. It is greatly to be regretted that the trade has not yet been able to secure greater precision in the nomenclature of timbers.

The handbook is full of information, and should prove useful to all engaged in the timber industry and its allied trades.

GENERAL NOTES.

BRITISH COTTON-GROWING.—In the House of Commons, on February 23rd, the Under-Secretary of State for the Colonies was asked if the British Empire only grows 24 per cent. of the total cotton of the world, and if he would give the percentage of the cotton now grown in British Colonies, and indicate its gradual growth since 1910, also stating what special steps are being taken to increase cultivation to the fullest extent. The reply was as follows: The figure of 24 per cent. is for the whole Empire, including India, Egypt, and the Sudan. The percentage for the Colonies and Protectorates with which the Colonial Office is responsible is about one-quarter of 1 per cent. Apart from the small but valuable West Indian crop the production is almost entirely in tropical Africa. The figures range from about 38,000 bales of 400 lb. in 1910 to 75,000 bales in 1914 and 47,000 bales in 1918. The recent falling off is largely due to the decreased output of Uganda during the war period, but a greatly increased Uganda crop is now expected. These figures do not include the large amount of cotton grown in Nigeria for the local market, which does not pass through European hands. The possibilities of increased production will in certain cases be limited by the competition of other crops or the sparseness of the local population, but every effort is made to encourage cotton-growing, and special attention has been given to the improvement of Colonial Agricultural Departments. The Colonial Office is in close touch with the Empire Cotton Growing Committee.

British Industries Fairs.—Exhibitions in connection with the fifth British Industries Fair were opened at the Crystal Palace and in Glasgow and Birmingham on February 23rd. The classes of goods on view at the Crystal Palace, where the stalls extend to five miles and cover an area of twenty acres, include cutlery, silver and electro-plate, jewellery, clocks and watches, glassware, china, earthenware, paper, stationery, printing, fancy leather goods, brushes, toys, sports goods, scientific instruments, optical and photographic goods, drugs and druggists' sundries, musical instruments, furniture, and art needlework requisites. The exhibits in Birmingham consist largely of machinery, metalware, hardware goods, and household utensils. Features at Glasgow are clothing, general textiles, foodstuffs, and chemicals. Admission is restricted to business men, of whom 150,000 were invited. The *Board of Trade Journal* mentions that the Fair has been well attended from the opening, not only by British trade buyers but by overseas representatives, including buyers from South Africa, Netherland East Indies, the United States, Finland, and on behalf of the Esthonian Government, as well as from European allied and neutral countries. It is announced that four travelling exhibitions of British goods are to be established for the Overseas Dominions, the Far East, the United States and South America. In addition, the opening of showrooms on the Continent and elsewhere for the display of British productions is under consideration by the Government.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m. :—

March 10.—H. M. Thornton, "Gas in relation to Industrial Production and National Economy." Sir Robert A. Hadfield, Bt., D.Sc., F.R.S., will preside.

March 17. — William Worby Beaumont, M.Inst.C.E., "Street Passenger Transport of London." Kennedy Jones, M.P., Chairman, Select Committee on Transport (Metropolitan Area), will preside.

March 24.—L. Gaster, "Industrial Lighting in its relation to Efficiency."

April 14.—Joseph Thorp, "The Fundamental Basis of Good Printing."

April 21.—Air-Commodore Edward Maitland, C.M.G., D.S.O., A.F.C., "The Commercial Future of Airships."

April 28.—Charles H. Sherrill, "Stained Glass."

May 5.—Dr. C. E. Kenneth Mees, "A Photographic Research Laboratory." Sir Henry Trueman Wood, Chairman of the Council, will preside.

Indian Section.

Friday afternoon, at 4.30 p.m. :—

March 19.—Sir William S. Meyer, G.C.I.E. K.C.S.I., Financial Member of Council of the Governor-General of India, 1913-18, "The Indian Currency System and its Developments." The Right Hon. Lord Chalmers, G.C.B., LL.D., will preside.

Thursday afternoons, at 4.30 p.m. :—

April 15.—Brigadier-General Lord Montagu of Beaulieu, C.S.I., "Roads and Transport in India."

May 20.—Sir George Cunningham Buchanan, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

Monday afternoon, at 4.30 p.m. :—

May 31. — Albert Howard, C.I.E., M.A., A.R.C.S., F.L.S., Imperial Economic Botanist to the Government of India, "The Improvement of Crop Production in India."

Date to be hereafter announced :—

Sir Valentine Chirol, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

Colonial Section.

Tuesday afternoon, at 4.30 p.m. :—

May 4.—Professor William A. Bone, D.Sc., Ph.D., F.R.S., "Lignite."

Indian and Colonial Sections.
(Joint Meeting.)

Friday afternoon, at 4.30 p.m. :—

June 4. — Professor Sir John Cadman, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E., "The Oil Resources of the British Empire."

Dates to be hereafter announced :—

Graily Hewitt, "Rolls of Honour."

Charles Crowther, "The Arts and Crafts of Japan" (with examples from the author's private collection).

William Cramp, D.Sc., M.I.E.E., "Pneumatic Conveying Plants, with special reference to the Transport of Grain."

Cantor Lectures.

Monday evenings, at 8 p.m. :—

Walter Rosenhain, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

Arthur Thomas Bolton, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.

May 3, 10, 17.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 8...Chadwick Public Lectures, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m. General Sir John Goodwin, "Military Hygiene in Peace and War." (Lecture I.)

Royal Institution, Albemarle-street, W., 3 p.m. Sir John Cadman, "Modern Developments of the Miners' Safety Lamp."

Mechanical Engineers, Institution of, Storey's-gate, S.W., 8 p.m. (Graduates' Meeting.) Mr. T. F. Davey, "British Association Threads."

Geographical Society, Kensington-gore, W., 5 p.m.

TUESDAY, MARCH 9...University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Mr. A. D. Innes, "The Mogul Period in the History of India." (Lecture V.)

Metals, Institute of (Local Section), Chamber of Commerce Buildings, New-street, Birmingham, 7.30 p.m. Mr. O. W. Ellis, "The Amorphous Phase Theory and its Applications."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. Keith, "British Ethnology: the Invaders of England." (Lecture II.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Major-General Sir G. M. Heath, "Royal Engineer Work in the Great War."

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 7.30 p.m. Mr. W. J. Pearce, "The Selection and Purposes of Colour in Decorative Work."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. G. I. Higson, "Photomicrography in Photographic Research."

Colonial Institute, Central Hall, Westminster, S.W., 8 p.m. Mr. A. O. Neville, "Through the North-West of Australia."

Horticultural Society, Vincent-square, Westminster, S.W., 3 p.m. Mr. J. Hudson, "Fruits which can be grown under Glass without Fire Heat."

Physicians, Royal College of, Pall-mall East, S.W., 5 p.m. Dr. J. L. Birley, "The Principles of Medical Science as applied to Military Aviation." (Lecture I.)

WEDNESDAY, MARCH 10...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. H. M. Thornton, "Gas in Relation to Industrial Production and National Economy."

Royal Institution, Albemarle-street, W., 3 p.m. Sir John Cadman, "Petroleum and the War."

Geological Society, Burlington House, W., 5.30 p.m.

Industrial League and Council, Carpenters' Hall, Throgmorton-avenue, E.C., 5.15 p.m. Mr. G. J. Wardle, "Industrial Unrest and Whitley Councils."
Central Hall, Westminster, S.W., 7.30 p.m. Mr. E. J. P. Benn, "Should Wages be Lowered?"

United Service Institution, Whitehall, S.W., 3 p.m. Captain P. Worthington, "The Work of the Kite Balloon on Land and Sea."

THURSDAY, MARCH 11 ... Metals, Institute of, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 4 p.m. Annual General Meeting.
8 p.m. 1. Messrs. G. D. Bengough, R. M. Jones, and Ruth Pirret, "Fifth Report to the Corrosion Research Committee." 2. Messrs. R. Seligman and P. Williams, "The Action on Aluminium of Hard Industrial Waters."

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Child Study Society, at the Royal Sanitary Institute, 90, Buckingham Palace-road, S.W., 6 p.m. Miss M. J. Reaney, "The Educational Needs of Adolescence."

Dyers and Colourists, Society of, Bradford. Mr. G. G. Hopkinson, "Dyeing of Fast Colours on Cotton."

Royal Institution, Albemarle-street, W., 3 p.m. Colonel E. Gold, "The Upper Air."

Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. 1. Mr. W. H. Patchell, "Notes on Operating a By-product Producer Gas Plant for Power and Heating." 2. Mr. S. H. Fowles, "Production of Power from Blast Furnace Gas."

Historical Society, 22, Russell-square, W.C., 5 p.m. Paper on "Some British and Allied Archives in War Time. II.—British Dominions and Crown Colonies Overseas; France; Belgium; Balkan States."

Physicians, Royal College of, Pall-mall East, S.W., 5 p.m. Dr. J. L. Birley, "The Principles of Medical Science as Applied to Military Aviation." (Lecture II.)

FRIDAY, MARCH 12...London Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. The Earl of Lytton, "Inns and Taverns of London—their better adaptation to the Public Need."

Royal Institution, Albemarle-street, W., 9 p.m. Mr. W. W. R. Ball, "String Figures."

Auctioneers and Estate Agents, Institute of, 34, Russell-square, W.C., 7.45 p.m. Sir William Wells, "Professional Education."

Malacological Society, Burlington House, W., 8 p.m.

University of London, University College, Gower-street, W.C., 5 p.m. Dr. T. Borenius, "Mediæval Art." (Lecture IX.)

Astronomical Society, Burlington House, W., 5 p.m.

Metals, Institute of, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 10.30 a.m. 1. Mr. J. N. MacLean, "The Art of Casting in High Tensile Brass." 2. Messrs. H. Moore and S. Beckinsale, "The Removal of Internal Stress in 70 : 30 Brass by Low Temperature Annealing." 3. Dr. W. Rosenhain, Mr. J. L. Haughton, and Miss K. Bingham, "Zinc Alloys with Aluminium and Copper." 4. Dr. W. Rosenhain, "A Model for representing the Constitution of Ternary Alloys." 5. Mr. A. C. Vivian, "Tin-Phosphorus Alloys." 6. Messrs. W. C. Hothersall and E. L. Rhead, "Some Notes on the Effect of Hydrogen on Copper."

2.30 p.m. 1. Mr. W. E. Alkins, "The Effect of Progressive Drawing upon some Physical Properties of Commercially Pure Copper." 2. Mr. F. Johnson, "The Influence of Cold Rolling on the Physical Properties of Copper." 3. Mr. J. L. Haughton, "The Study of Thermal Electro-Motive Force as an aid to the Investigation of the Constitution of Alloy Systems." 4. Mr. H. H. Hayes, "Note on the Polishing and Etching of Zinc for Micro-Examination." 5. Mr. W. E. Hughes, "Idiomorphic Crystals of Electro-Deposited Copper."

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

SATURDAY, MARCH 13...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Positive Rays." (Lecture IV.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

WEDNESDAY, MARCH 17th, at 4.30 p.m. (Ordinary Meeting.) WILLIAM WORBY BEAUMONT, M.Inst.C.E., "Street Passenger Transport of London." KENNEDY JONES, M.P., Chairman, Select Committee on Transport (Metropolitan Area), will preside.

FRIDAY, MARCH 19th, at 4.30 p.m. (Indian Section.) SIR WILLIAM S. MEYER, G.C.I.E., K.C.S.I., Financial Member of Council of the Governor-General of India, 1913-18, "The Indian Currency System and its Developments." THE RIGHT HON. LORD CHALMERS, G.C.B., LL.D., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

THIRTEENTH ORDINARY MEETING.

WEDNESDAY, MARCH 10th; SIR ROBERT A. HADFIELD, Bt., D.Sc., D.Met., F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Bond, Colonel Charles John, C.M.G., F.R.C.S., Leicester.

Gane, Charles, London.

Kahn, Otto H., New York City, U.S.A.

Kerfoot, Thomas, Gee Cross, Cheshire.

Murray, Victor F., B.Sc., London.

Pullin, Victor Edward, London.

Rawson, Thomas Gregory, Borrowash, Derby.

Reed, Clifford, Nelson, Lancashire.

Robarts, Harvey B., M.A., F.R.G.S., London.

Roberts, Joseph Henry, Rotherham, Yorks.

Tagore, Raj Kumar Nawab S. K., Calcutta, India.

The following candidates were balloted for and duly elected Fellows of the Society:—

Aiyar, S. Paramesvara, M.A., B.L., Travancore, South India.

Cantrell, T. B., Liverpool.

Gurtu, Pundit Sri Krishen, M.A., M.Inst.C.E., Morar, Central India.

Healey, William, B.Sc., Assoc.M.Inst.C.E., Assoc.M.I.Mech.E., London.

Knox, George, F.G.S., Cardiff.

Walker, Frederick H., B.Sc., A.I.C., Newcastle-on-Tyne.

A paper on "Gas in Relation to Industrial Production and National Economy" was read by Mr. H. M. THORNTON, J.P., Assoc.Inst.C.E.

The paper and discussion will be published in a subsequent number of the *Journal.*

THE ALBERT MEDAL.

The Council will proceed to consider the award of the Albert Medal of the Royal Society of Arts for 1920 early in May next, and they therefore invite Fellows of the Society to forward to the Secretary on or before Saturday, March 27th, the names of such men of high distinction as they may think worthy of this honour. The medal was struck to reward "distinguished merit in promoting Arts, Manufactures, and Commerce."

The list of those who have received the medal since its institution in 1864 was printed in the last number of the *Journal.*

COVERS FOR JOURNALS.

For the convenience of Fellows wishing to bind their volumes of the *Journal*, cloth covers can be supplied, post free, for 2*s.* each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

NINTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 11th; REAR-ADMIRAL SIR DOUGLAS EGREMONT R. BROWNRIGG, Bt. C.B., Chief Censor, Admiralty, 1914-18, in the chair.

The paper read was --

THE DAZZLE PAINTING OF SHIPS.

By LIEUT.-COMMANDER NORMAN WILKINSON, R.N.V.R., O.B.E., R.O.I., R.I.

The paper I am about to read to you deals with the origin and development of dazzle painting, and I shall endeavour to show the reasons for its adoption, as opposed to painting a ship with a view to achieving invisibility. At first sight it would appear that the latter was the sound line to take when seeking to render a ship immune from submarine attack, but on examination I think I can show you the fallacy of painting a vessel in this manner.

Dazzle painting is a method to produce an effect (by paint) in such a way that all accepted forms of a ship are broken up by masses of strongly contrasted colour, consequently making it a matter of difficulty for a submarine to decide on the exact course of the vessel to be attacked.

I shall hope to show you that so-called invisibility against submarine attack is not only impossible, but dangerous, and consequently, if a vessel can be seen at all, it does not matter how visible she is, providing her course remains a matter of question to the attacker. The accurate determination of a vessel's course is the prime factor required by a submarine commander to ensure successful attack.

Many animals and birds are provided by Nature with an external scheme of colouring which harmonises with their surroundings in such a way as to make them practically invisible to an enemy, so long as they are in a state of rest. This applies also to a number of animals more or less immune from attack, and is provided in order that they may lie in wait for unsuspecting prey.

All the previous attempts which had been made to utilise paint as a defensive measure, when dealing with ships, were with a view to rendering them invisible.

Land camouflage, as practised in the theatres of war, has developed along the lines of protective colouring or invisibility, and has reached a remarkable pitch of perfection. It is not difficult to see the reason for this. When desirous of hiding any particular object, such as a battery of guns from the enemy, you are more or less assured of surroundings of a broken nature, little likely to be subject to a change of colour, and, providing you can successfully imitate these surroundings, by covering your battery with fabric, etc., you have practically achieved your end. There is, of course, a highly technical side to this work, and some of our most skilled artists have been working on the problems presented throughout the war; but these I will not go into now, as they have little or no bearing on the special form of camouflage I am about to deal with.

If we turn again to sea camouflage, *i.e.* the painting of ships as a defensive measure, we find an entirely different order of things. Firstly, the ship is in motion. Secondly, you have two elements, sea and sky, subjected to constant changes of colour and light. Thirdly, there is the horizon, a most difficult problem to deal with, which is either a hard clear-cut edge against a brilliant sky, or elusive and blurred. Conditions vary greatly according to the particular part of the globe under survey.

Let us take two localities characteristic of these conditions, and also as being the great hunting grounds of the enemy submarine during the war, viz., the Mediterranean and the coast of Great Britain. You find, generally speaking, the weather conditions in the first named are: Clear sky, dark sea, with sharply defined horizon; while round the British coast you get a softer horizon, and less contrast between sea and sky, due to moisture in the atmosphere and other local conditions. I speak with some experience, having been a marine painter with long experience at sea, and constant observation of weather, colour, etc. Now it will be at once apparent that a ship painted with a view to obtaining invisibility in one locality has very little chance of being successful in the other, and having once been seen by a submarine, from that moment loses any defensive qualities paint can give her.

Let us suppose you are setting out to paint a ship in order to bring about invisibility. You first of all require her hull to be in a fairly clean condition, as you are intending to paint her in very light delicate shades of colour. Assuming the very unlikely case of getting your vessel in this condition, you commence work. On the second day, when you are well on with your painting, a coal lighter comes alongside, and as the life of the country is dependent on the ship getting to sea, you cannot stop this operation. Therefore, your clean paint has a film of coal dust of varying intensity all over it. She has then to take in or discharge cargo, with its consequent wear and tear of paint, warps or tenders are rubbing her sides, scupper pipes and endless exhausts trickle down her sides, which makes it impossible to paint here at all. However, having got over these difficulties as best

you can, she goes to sea. Now comes a further trial, her hawse pipes run streaks of rust down either bow, and her water-line becomes rusty or is coated with oil deposit from her stay in port, and finally you cannot expect her short-handed crew to devote hours of their time to constantly re-painting her to your exact shades of subtle colours. Assuming, however, that you do get her to sea in perfect condition as regards paint, can you make her smoke invisible? With a following wind, this smoke will ascend hundreds of feet into the air, quite possibly at a time when a watchful submarine is looking out for prey; he does not need to look for your invisible ship, he knows she is there and has an easy job.

All these difficulties were practically non-existent with the dazzled ship, the requirements in her case were strong contrasts of colour, and even though your light colours were dirty the juxtaposition of black made them appear clean by comparison. I have seen an old tramp steamer in the London Docks, which had not had a touch of new paint on her dazzle scheme for five months, and the effect of the distortion was perfectly good. Had she been painted for invisibility scarcely anything would have remained of her scheme, and the most pronounced optimist could not have claimed that she suggested anything of an invisible nature. It always struck me that the dazzled ships seemed cleaner than an "all one coloured" ship, on the principle that a white table-cloth will look dirty sooner than a patchwork quilt.

It appears to me that one reason for the continued attempts to obtain invisibility at sea has been largely contributed to by the fact that vessels are nearly always seen from the bridge or look-out of another vessel, or from a shore station, all of which vantage points are a considerable height above the sea-level, thus giving the observer a sea background of a fairly dark tone. Now the submarine commander's point of view is entirely different. He sees every ship against a sky background only, with practically no foreground of water, which is a very different proposition.

A ship seen from another vessel's bridge may, under certain weather conditions, achieve a partial degree of invisibility when the colour of the ship's hull and the sea happen to coincide. But this same ship, seen at the same time by a submarine, will appear as a darkish silhou tte against the sky.

This partial invisibility will only be gained in small vessels of the cargo type, where there are no promenade or hurricane decks, or other structures liable to cast shadows.

At the commencement of the scheme I was frequently told that invisibility could be gained by the application of Thayer's law of shadow elimination, and that if you painted the undersides of a passenger deck white, you can overcome these deep shadows. This I can definitely state to be a fallacy. No paint which is in itself dependent on the sky for light can overcome a shadow of this density. There is one instance where white paint can be utilised to overcome shadow, and is sometimes very useful. This is on a vessel with a marked flare to the bow, by painting the upper portion of the hull with white and the lower part a grey or blue, the appearance of the flare can be largely neutralised, and will often tend to alter the character of the vessel in a marked way by flattening the bow. The reason for the success of this measure is owing to the strong reflected light cast upwards on to the flare of the bow, and consequent illumination of the white paint. This applies more forcibly when the vessel is under weigh.

An important argument against invisibility at sea is the smoke. Where there is an unlimited supply of hard coal, or the vessel is oil burning, you may overcome this difficulty to a certain extent, but there will be times when any vessel will show smoke, so that even if it were possible to achieve complete invisibility of hull, it might be at that moment that her position would be disclosed to an enemy submarine on the look-out. I suggested to the Admiralty, in the early stages of dazzle painting, that the question of a vessel's smoke should be gone into, with a view of obtaining a really efficient smoke destructor, such as you have in a shore factory, in that it would prevent a vessel, hull down, from being observed. Where you have a ship with a following wind, burning soft coal, her smoke will ascend vertically and make her presence known at a great distance. Two further strong arguments against obtaining invisibility are the bow wave and the stern wash, both of which I saw no way of overcoming.

I have attempted to give you one or two reasons showing why, in my opinion, any attempt to gain invisibility of a ship at sea by means of paint is bound to fail. There remains, however, one more factor, which I think finally disposes of the last vestige of chance in this direction. This is the director hydrophone. This instrument puts the vessel painted for invisibility more or

less in the position of the ostrich. We know the Germans had developed the hydrophone to a high state of efficiency, and were able, by its use, to decide not only on the probable class of a single ship, or a number of ships roughly, if in convoy, but could, by a series of listening observations, obtain the general direction in which the ship or convoy was proceeding. This is naturally only approximate, but will be of considerable help in the very early stages of the attack. After deciding on the direction, the submarine will rise and commence visual work with the periscope, and it is from this moment that the ship painted all one light colour, or in a series of small spots or parti-coloured paint, becomes a comparatively easy prey; and although she may be zigzagging her course can be determined far more easily than a vessel painted in the way I shall describe. This determination, of course, is the prime factor required by a submarine when making an attack.

It was from the moment that I realised the hopelessness of obtaining invisibility that it seemed to me something could be done with paint on entirely different lines. At the time my proposal was put forward, all transports were painted black from waterline to truck. I was continually on patrol in the Channel in May 1917, and it struck me that of all the colours that could have been chosen, this was the most dangerous. A submarine commander, had he been given the choice of colours to ensure successful attack, would most certainly have decided on black, both for day or night. My reason for relying on paint was the knowledge that the employment of fabrics, such as netting, gauze, or the numerous other articles used in land camouflage were impracticable. Endless propositions of this nature were put forward by people interested in the question of invisibility, but in nearly every case those making them have little experience of the sea and its ways, and do not realise its power.

Another factor not remembered by many, even when experienced, is the human element. The sailor is temperamentally conservative. You may rig endless devices in harbour, and make your ships as invisible as you can, but twenty-four hours out of harbour they may be swept by a gale, or even a strong breeze suffices, and what remains of your canvas strips and muslin trimmings? Not a shred! Does your sailor, believing in your schemes, painstakingly re-rig your pet devices? If I know anything of him, he does not. If he is sunk, he is sunk; but he will not put in half his watch below replacing your fancy fittings. It will be seen, therefore, that paint was the only practical means of disguise which could be applied to the hull of a vessel in such times of stress.

There are, of course, certain important and simple structural additions of a permanent nature which can be made, if time permits, to increase the difficulties of an attacking submarine, but these I will touch on later.

It was the knowledge that the all-important factor to a submarine commander was the determination of a ship's course which gave me the idea that, if the accepted form of a vessel could be so completely broken up by contrasting colours and tones of paint as to destroy her outline and general shape, a large point would have been gained towards increasing the difficulties of attack.

The primary object of this scheme was not so much to cause the enemy to miss his shot when actually in firing position (although this has happened in a number of cases), but to mislead him, when the ship was first sighted, as to the correct position to take up.

With a vessel of ten knots or over, a submarine, having once failed to obtain a good position, has little or no likelihood of regaining that position, owing to insufficient underwater speed. Should he decide to come up and overtake the ship by surface speed, the ship attacked, being armed, has every chance of a successful escape, and I should consider it a great testimonial to the painting that it had brought the enemy to the surface.

In submitting this scheme to the Admiralty, I made no claim that a ship so painted was certain of escape, but simply that she must present a more difficult proposition to a submarine, and could not be easier than an "all grey ship." Another point was, that it meant little or no delay to the vessel, as every ship must be painted for weather protection. The fact that nothing of a structural alteration was required was important, and, finally, the cost was negligible, as upwards of one hundred vessels could be painted for the cost of one good class cargo boat and cargo.

The Admiralty immediately placed a vessel at my disposal for the purpose of experiment. This particular ship, H.M.S. "Industry," was employed on a regular run between Plymouth, Portsmouth, Pembroke, Chatham, and Queenstown, and therefore constantly in the danger zone. She was painted to a design I had prepared and completed in three days whilst loading, and sailed to schedule time.

Orders were meanwhile issued to all navy vessels and shore stations to report on her appearance, when met with; but, knowing the length of time these reports would take to filter through, and also that this first design could not be all I wished, I approached the Admiralty for a larger development of the scheme at once in order to get more frequent reports. Within a day or two fifty transports were ordered to be painted as rapidly as opportunity offered. Each of these vessels was painted differently in order to prevent the enemy from becoming accustomed to any particular design. Some designs were, of course, more successful than others, and I eliminated those which were reported on as not giving the required distortion. Some time before the end of the war we had arrived at the most successful type of design, namely, striped designs. These were commented on by a great number of seamen as being by far the best for upsetting the calculation of a ship's course. These stripe designs not only succeeded in breaking up the above-water structures of a vessel very successfully, but they also had the advantage of being practically fool-proof in application—a most important point. In the early stages of the scheme, before we were able to collect and train a staff of outport officers, we had considerable difficulty in getting the designs intelligently applied, as it largely depended on the personality of the particular foreman in charge of a job whether the design was a success or not. But I found that these foremen painters became highly interested in the work as soon as they thoroughly understood its meaning, and later were of the greatest assistance in carrying through the scheme. I attribute this very largely to the fact that, as far as my observation goes, every foreman painter has a feeling deep down that he is by instinct an artist who happens to be dealing with art in a broader sense than the ordinary picture painter. This, at least, has been borne in on me by confidences I have received during visits to ships in the course of painting.

The method of procedure by which the ships became painted will probably interest you.

In the initial stages a small model in wood was made to scale of each ship, on this a design was painted in wash colours for the purposes of rapid alteration. This model was then carefully studied on a prepared theatre through a submarine periscope, various sky backgrounds being placed behind her alternately. A satisfactory design having been evolved, giving the maximum distortion, the model was then handed to a trained plan maker and copied on to a 16th-inch scale profile plan of the ship on white paper, showing port and starboard side. The plan was then sent to the outport officer at the port at which the particular ship was lying, and transferred under his supervision to the ship. With the extension of the scheme to the whole mercantile marine, it became impossible to make a model and plan for every ship, and I determined to divide the mercantile marine into typical classes of vessels. For each type of ship a number of designs was made, according to the demand for the particular class, and each outport officer was kept supplied with all designs, so that on the arrival of a ship requiring a plan he was able to select one which fitted her as nearly as possible. This scheme worked wonderfully well, but needed a great deal of skilled supervision in the early stages, as, with a ship, say, 350 ft. long and a plan of 380 ft., it could not be left to a foreman painter to deal with. When the scheme had been in operation for some time, many of these foremen became so interested and keen that we were able to leave the adaptation of a plan to a ship of different length to them—in a number of cases with conspicuous success. These men were a great help, as the bulk of work grew enormously, and we sometimes had as many as one hundred vessels painting at a time in one port, with only two or three officers to attend to the lot with long distances to cover.

At first, although explained in the Admiralty Memorandum, some confusion still existed amongst seamen as to the object of dazzle painting, and a certain number of reports showed that it was thought invisibility was still being aimed at. However, when better understood, almost every report showed that the new scheme of painting was accepted as an effective contrivance in assisting to combat the submarine. From a large number of reports it could be seen that the idea of making the course difficult to determine had been thoroughly grasped. I will read you one or two of these, as illustrating the way in which the new form of painting was received.

H.M.S. "Martin,"

September 27th, 1917.

"Sighted oiler 'Clam' about six miles, four points on starboard bow, and for some time could make nothing of her. When about four miles distant, I decided it was a tug towing a lighter with a short drift of tow rope. The lighter, towing badly and working to the

windward, appeared to be steering an opposite course.

"It was not until she was within half a mile that I could make out she was one ship steering a course at right angles, crossing from starboard to port. The dark painted stripes on her after part made her stern appear her bow, and a broad cut of green paint amidships look like a patch of water. The weather was bright and visibility good. This was the best camouflage I have ever seen."

REPORT ON H.M.S. "EBRO" FROM H.M.S. "SAYONARA."

October 1st, 1917.

"September 25th, 9.55 a.m., sighted H.M.S. 'Ebro' in the Sound of Mull on the port bow, end on.

"She appeared to alter course to port immediately after, and seemed to continue to do so, whereas, in reality, she was altering her course to starboard.

"I should think confusion would be caused in aiming gun or torpedo.

"I was so sure that she was trying to cross my bows that I was on the point of stopping my engines and going full speed astern to avoid a collision, when I discovered that she was altering course to starboard. After passing the vessel it was almost impossible to say how she was steering."

H.M.S. "MISCHIEF,"

October 18th, 1917.

"Sir,—I desire to bring to your notice the following facts :—

"At about 9.30 a.m. on Wednesday, October 17th, whilst proceeding up the Firth of Clyde in H.M.S. 'Mischief,' I observed a convoy of some eight ships, oilers, etc., proceeding to sea in a single line ahead.

"No. 6 in the line was 'dazzle painted,' and appeared to me to be steering at least eight points different to the other ships in the line. So remarkable was this optical illusion that I sent for all my officers and asked their opinion as to the course of the ship. Not one officer agreed within four points. This optical illusion remained until the ship in question was past our beam, when it was seen that she was steering the same course as the others.—I have the honour to be, etc.

"(Signed) CYRIL WARD, Commander."

S.N.O. "ARDROSSAN,"

September 25th, 1917.

"*Vessels unknown.*—In all cases, more especially when viewed at a distance of about three miles, the vessels presented an appearance of being grotesquely out of all proportion; infinitely more so when the sun shone directly upon them. When approaching, it was not until the vessels were quite near that it was possible to see their bows, even when quite close; at about half a mile the bows seemed to be directly under the bridge. The deception as to distance between bow and bridge, which in all cases appeared extremely high, was indeed remarkable."

OFF SOUTH ROCK LIGHTSHIP,

October 6th, 1917.

"'*Clam.*'—Effect of camouflage painting was that the vessel, at a distance of about two to three miles, appeared as a wreck on her beam ends, and patches of paint on bows caused absence of perspective. It was difficult to locate the vessel's stern. This was increased by the fact that she had only one thin, short mast placed well abaft the centre of the ship."

H.M.T. "ANZAC,"

August 15th, 1917.

"'*Ocean Monarch.*'—(*a*) No apparent difference was noticed in speed, but the course she was steering was particularly deceptive. At times, principally when viewed from ahead, she appeared to be steering as much as six points to port of her actual course; my attention being called by my second hand on two occasions when he thought this was actually taking place.

"(*b*) It was difficult to tell what type of ship she was. At times she appeared to be only half a ship, *i.e.* a vessel with her bow and stern cut off.

"(*c*) When I was right ahead of her, and she was heading directly towards me, sun right head of her as before, she appeared to be heading six points off her course to port."

CAPTAIN BARTTELOT,

September 25th, 1917.

"*S.S.* '*Millais.*'—Convoy was observed by three destroyer officers running trials at distances varying from two to four miles.

All three officers agree that the 'dazzle painting' of the 'Millais' was a huge success. They state that it was quite impossible to state her course even approximately, except when the sun lit up her masts. Lieut.-Commander Harrison stated he could not tell her course within twelve points."

13 O.B. CONVOY SECTION.

"*H.M.S.* '*Mantua.*'—The dazzle scheme on the starboard side of 'Ascanius' is excellent. The ship sometimes appears to be going in the

opposite direction, and in misty weather her course cannot be judged within eight points.

"On a bright moonlight light she was invisible at one mile.

"I am strongly of opinion that all ships should be painted on these lines."

As a result of these and a large number of other reports, it was decided by the Admiralty in October, 1917, under the Defence of the Realm Act, to paint the whole British mercantile marine, and a considerable number of war vessels employed on convoy and other duty. I will read you the Admiralty Memorandum on the subject as issued :—

INSTRUCTIONS TO "DAZZLE" OFFICERS.

Confidential Admiralty Interim Order No. 37531/6.

"It has been decided to paint all merchant vessels and armed merchant ships, and certain of H.M. ships, with the 'Dazzle' scheme of painting.

"This scheme is based upon the principle that invisibility at sea being unattainable, some protection may be afforded by painting ships in such a way as to confuse an enemy submarine, and, by causing doubts as to the course, speed and distance, thus delay the discharge of the torpedo and cause uncertainty of aim.

A number of designs are in preparation which will enable a suitable plan to be selected for any particular ship that may come in hand for refit or painting.

"Officers are being selected who will represent the Director of Naval Equipment at all the principal shipping ports, and who will be furnished with plans prepared at the Admiralty."

For a time, in the early stages of the scheme, I hesitated to use white paint for various reasons, but after considerable experience, it was found to be the best "colour" for those parts of the ship intended to be invisible. I will read you a few remarks from one of my officers on white paint :—

REPORT FROM LIEUT. H. A. YOCKNEY, R.N.V.R.,
Belfast,
February 3rd, 1918.

"*Submitted.*—Between January 31st and February 1st, I took the opportunity of proceeding in H.M.Y. 'Albion III.' to view the appearance of the O.B. Convoy No. 44 while at sea. The weather conditions on this occasion were fairly typical of those usually experienced in the North Sea, namely: Wind S.E., force 4 to 6, sea 4, visibility 3–5 miles. My conclusions were as follows :—

"(1) That when white had been used extensively in a dazzle design, by far the best results appear to be obtained.

"(2) That the best dazzled ship in the convoy was the S.S. 'Demosthenes.' The power of hull design chiefly lies in the large amount of white employed on the upper portion of her bows and bridge. From a number of points of view this white portion appeared to be a part of the midship superstructure, producing a very confusing effect, it being quite impossible to make out the ship's course, or to discover the form of the bridge.

"(3) That the design of the port side (I did not see the starboard side) of the S.S. 'Botanist' would have been improved had more white been used on some parts. From the bridge to a point abaft the funnel where white was prominent in juxtaposition to dark colours, a most awkward appearance was produced, but too large a portion of the painting of the hull aft was very weak, which helped to make judgment easier as to course of ship. I believe that some white about this portion would have much improved the design as a whole.

"(4) That the design on the S.S. 'Colonial' was not very effective. The contrasts between the colours used were not nearly intense enough, suggesting the requirement for some white.

"(5) That the stern and outline of stern should be broken up by colours in strongest contrast, always including white. The white as schemed in bows of S.S. 'Demosthenes' supports this view, and the officers of the 'Albion III.' spoke of a dazzled ship they had seen with poop cut off by white. The white, they say, completely destroyed the outline of the stern, and was mainly responsible for their having come to the decision that the ship was the best dazzled one they had seen."

Although I have told you that, from my point of view, it is impossible to obtain invisibility by painting, it is, nevertheless, possible to render parts of a vessel relatively invisible by contrast, and this is a large factor in "dazzle" painting.

The best method for achieving this is by painting your light parts of a design with two light colours, varying definitely in tone. By this I do not mean a blend of two colours in spots or squares, but in definite flat tones of each.

To deal first with the starboard side :—

Divide the vessel amidships; paint the fore end white, and the after end, say, No. 2 blue.

On the port side: Fore end No. 2 blue, and after end white.

This is the broad principle, but is subject to certain modifications. For instance, a colour should never be allowed to stop at an important constructional point, such as the stem or centre of stern; consequently, either the white on starboard side or the blue on port side, should be carried round the bow until checked by part of the dark pattern, and the same at the stern.

The reason for painting the ship in two tones of light colour was that there is a far greater chance of one of them harmonising with the sky behind, and thus giving great distortion to the vessel when used in conjunction with black or dark greys.

It may be said: Why not paint the vessel in a number of sectors of different tones? The reason for not doing so is that you must have large masses of simple colour if you desire to carry long distances. It was found, early in the stages of dazzle painting, that a number of light colours in close juxtaposition, simply meant a great increase in the labour of marking a ship out, and the cost of painting, without achieving any better result than that obtained by two simple masses of light colour.

A number of various light paints on the ship's side after exposure to weather, and the rough handling they are bound to be subject to, become reduced to one light tone of a neutral tint, and are no more effective than giving the parts you require to be light a single colour.

Coaling is only one of the operations which rapidly reduce subleties to nothing, and with the urgency and rapidity with which ships were handled in ports during the war you could not indulge in elaborate schemes of painting requiring constant attention. If you are to deal with large numbers of ships, it is essential that whatever scheme is adopted should be simple of application. I have found that, although the scheme is reduced to the simplest possible method, it requires constant attention and inspection to ensure vessels being painted in keeping with the plans. The simpler your design, the greater degree of distortion you can achieve.

The most important parts of a ship on which to obtain distortion are in the neighbourhood of the stem and the forebridge, both of these are of great use to a submarine in determining the course. Where a ship was being painted against time, these parts were attended to first.

The colours mostly in use were black, white, blue and green, either in their primary condition, or mixed to various tones. When making a design for a vessel, vertical lines were largely avoided. Sloping lines, curves and stripes, are by far the best and give the greatest distortion. The process of marking out a ship was soon learned by the foreman painters under proper supervision. As an instance, the "Leviathan," ex "Vaterland," was marked out in just over two days, and it should be remembered that she is a very extreme type.

The fact that she took a considerable time to paint was due to the number of vessels painting in Liverpool at the time—forty, to be exact—and also to the area requiring paint, which is in the neighbourhood of three acres. The output of dazzled ships was definitely restricted to the supply of skilled painters obtainable, and the quantity of paint available. Warships were dealt with by their own crews.

The American destroyers and patrol vessels in European waters, for which I made upwards of 120 designs, were painted in the majority of cases by their own crews.

Soon after the commencement of unrestricted submarine warfare, I saw a certain number of U.S. merchantmen painted to various ideas, mostly on the lines of invisibility, and I must say it invariably seemed to me a waste of time and paint so to paint them. One I saw in Liverpool was closely covered with very small spots of grey, blue, and pink of a more or less regular pattern. This, at half a mile and upwards, showed as a flat tone of grey, and the long dark promenade decks and other shadow-casting projections would at once locate her to a watchful submarine, even supposing the hydrophone to be non-existent. These schemes were entirely abandoned after my visit to Washington in order to explain dazzle painting.

A certain number of warships were dazzle painted; these were mostly convoying cruisers, destroyers, minelayers, and vessels working with merchant vessels. Two battleships were painted with a view to experiment with range-finders, but I had stated in the early stages of the scheme that I attached no value to dazzle painting as an antidote to gunfire, as no paint has sufficient carrying power to be effective at the long ranges of a modern battle action.

The element of surprise is a big factor, and for this reason designs should be as varied as possible, and always different on both sides of a ship. A submarine sighting a vessel at some distance, would probably make as extended observations as she dared, and, in manœuvring

to get a general view of the ship, would obtain an entirely different impression on crossing her bows. Those extended observations would increase the chances of her being seen by watchful lookouts. I believe there is little doubt that in many cases attacks on dazzle ships have been abandoned by the enemy, without the vessel in danger of attack being aware of the fact, owing to the submarine finding too late that she had taken up a wrong position to ensure a successful shot.

A point of considerable interest, on which I have unfortunately very little information, is the German view of dazzle painting. Naturally, the enemy scoffed at our dazzled ships, and in one case a submarine commander professed to believe we were short of paint. Nevertheless, what came through in the way of evidence is somewhat convincing. The first report received was to the effect that German agents were sketching the designs of our vessels in Norwegian ports, and later that the German Admiralty had dazzle painted a liner, and had attached her to the submarine training depot at Kiel. Finally, a number of the surrendered submarines were painted in precisely the same manner as our merchant vessels, so that it looks as if considerable importance was attached to the training of their officers to the new conditions.

The French, Italian, and U.S. Governments took up the scheme, and a certain number of Japanese ships were about to be painted at the time of the Armistice. I had four French naval officers training in London, and the French Government started an establishment similar to our own, and a large number of designs were made under my supervision. I visited Washington at the request of the U.S. Navy Department, and explained dazzle painting, which was then officially adopted.

There was great keenness on the part of captains of ships for their vessels to be painted. The idea became generally understood, and appreciated by them, for they saw numbers of these ships at sea, and found considerable difficulty in determining the course steered, and realised that if from a bridge, with a clear and unrestricted view, this was true, it must, in the nature of things, be more difficult from a periscope with limited vision and short observation.

All I have said up to the present has dealt exclusively with the uses of paint as an anti-submarine asset, but in addition to this, the above-water structure of a ship can be dealt with in such a way as to make it a matter of considerable difficulty to estimate course, and I will give you a few points which I have actually observed as being the most important.

These are mainly the masts, funnels, bridge and anchors. The old convention of raking the masts and stacks is of the greatest assistance to a submarine when estimating the course of a ship. Where a ship of old design has two or more masts or funnels, this can be overcome to a certain extent by placing them in a vertical position. But by far the best camouflage is the single mast and funnel, in close juxtaposition as in the standard ship.

At the time when the enemy submarines were making a dead set at our oilers, and sinking them in large numbers, it was realised that something structural might be done to increase the difficulties of an accurate estimation of course. With this end in view, it was decided to remove the masts and place the funnel in a vertical position, at the same time a short stump mast was erected about 8 ft. out of the centre line and close to the funnel. I have seen a number of these vessels after this treatment had been carried out, and when combined with dazzle painting it was frequently a matter of considerable difficulty to decide when the vessel was head-on from a comparatively short distance.

The bridge, where, as in the majority of cases, this has a straight foreside, with rectangular ends, is a point much used by submarines for judging inclination. Dazzle painting in a great many cases breaks up a bridge in such a way that the actual angle of the bridge is impossible to determine, but there are conditions of light which no paint will overcome, consequently some structural device would increase the difficulty of an attacking submarine. It has always seemed to me that the best and simplest device is a bridge built on a slight continuous curve with rounded corners, thus doing away with any sharp angles likely to throw definite shadows, and so define the ends.

The bow anchors, where there are hawsepipe anchors, are a great assistance to determination of course. They should be dealt with so as to heave right up into slotted beds, with covering plates, or, failing this, set at different distances from the stem, one being, say, 1, 3, or 4 ft. further aft than the other.

A flush-decked steamer, similar to the Admiralty pattern oilers of the "Leaf" class, is far better than one with well decks.

The more erections you have on a ship's decks the greater chance a submarine has of getting

your course. The wings at the various breaks of a steamer's decks, as in a three-island ship, are bad from an anti-submarine point of view.

I have embodied, as far as possible in this paper the main features of interest as regards dazzle painting; there are, of course, a great many points on which it is only possible to touch lightly, but I hope, from what I have told you, you will have gained a closer view of its objects. As to its practical value in the war, the consensus of opinion is that a large number of vessels were saved by its use.

A number of dazzled ships were, of course, hit by torpedoes, but a far larger percentage of these made port than ships painted light grey, owing to the submarine making an erratic shot and so injuring the vessel in a less vital spot—that is, either right forward or aft. This demonstrates that even when in close contact with the target the commander was still uncertain as to the actual inclination.

Whether paint will ever play any part in future wars it is difficult to say; but, judging by the adaptation of comparatively mediæval weapons to modern conditions on the Western front, I think it would be safe to say that, in what I hope will be the dim future, strange looking craft will once more pursue their apparently erratic courses across the sea.

DISCUSSION.

THE CHAIRMAN (Rear-Admiral Sir Douglas Egremont R. Brownrigg, Bt.) said that he felt it an honour to be asked to preside at the Royal Society of Arts that afternoon. He was also a little puzzled. He did not know whether the subject discussed might not comprehend some of the work with which he himself was concerned during the war. He had further been bewildered by the use of the term "naval camouflage," which was the title of the paper as originally announced. He had turned to a well-worn French dictionary, where the nearest words he could find were *camisole*, *camomille*, and *camouflet*. The meaning of the last of these words was given as "stifler," and he wondered whether the Royal Society of Arts in its wisdom had coupled with this idea of camouflage the sister expression, and expected him that afternoon to fill the *rôle* of "camouflet." He was also interested to see that Lieut.-Commander Wilkinson did not himself use "camouflage" as the title of his paper, but called it "Dazzle Painting." The speaker had visited Lieut.-Commander Wilkinson's school at the Royal Academy in Burlington House, and he wondered whether he got the word "dazzle" from his staff, which consisted of about one hundred and twenty young women, whose looks and dress might have produced an effect of that description. To speak seriously, he was in Scapa Flow on the Good Friday of 1918, and standing in a ship four hundred yards from the "Ramillies" battleship—one of the two battleships which were camouflaged—both he and the other officers could not tell which way the ship was heading.

SIR EUSTACE H. TENNYSON D'EYNCOURT, K.C.B., thought there was no doubt that the work of Lieut.-Commander Wilkinson had had its very marked effect in baffling the German submarine encounters, and even though it might not always have prevented the submarines attacking the ships, he thought it prevented them distinguishing one ship from another in a good many cases. He believed that very often the Germans were particularly told to mark certain ships, and when they saw that the thing looked—as a seaman expressed it to him—"like a cross between a zebra and a sea-serpent going off for the week-end," they were nonplussed. He himself had had to disguise certain ships by making them look like other ships; this he did by altering the superstructures and so on, and he and those working with him had paid attention to such points as Lieut.-Commander Wilkinson had mentioned, confining themselves, for instance, to one mast or one funnel, or, in many cases, rounding the bridges. He was afraid he was not in a position to give actual figures regarding the number of camouflaged ships which passed through the danger zone as compared with the ships not camouflaged. He would hesitate to do so with the Chief Censor present, fearing that that official would transfix him with his blue pencil, which he believed he still carried. But the result did show that there was a distinct advantage for the dazzle ships. One point must have struck all present that afternoon, namely, the very thorough manner in which Lieut.-Commander Wilkinson had gone into the whole subject. One only had to visit his school at the Royal Academy to see how carefully every type of ship was considered, the many experiments which were made in different lights, and so forth. He was perfectly sure that everything which could possibly be done had been done. Lieut.-Commander Wilkinson had alluded to the cost of the matter. This was really very small. In the aggregate, of course, it amounted to a considerable sum, but the cost of a little paint would very soon be wiped off by the saving even of one ship. It was really a great economy, even if only quite a few ships could be saved. And probably in the end it was a much greater economy than was generally conceived. The difficulty, of course, was to know how many ships were saved. The country owed a deep debt of gratitude to Lieut.-Commander Wilkinson for the work which he had so ably summarised in his interesting paper.

COMMANDER E. S. LAND, C.C. (United States Navy), said that he was a little prejudiced with regard to camouflage on his first introduction to the subject, now quite a number of years ago. It fell to his lot in the Navy Department to be what was

known as the "fool killer," that is to say, to size up inventions, applications for patents, and things of that sort, and to rule out those which were obviously impracticable or absurd. One of the first that he had to do with was a process for making a ship invisible. The idea caught the ear of someone in authority, and a ship was allotted to this inventor, who thereupon went to the Navy Yard and requested the captain to remove himself and his entire crew for forty-eight hours. This gave rise to some consternation, and in the end the whole thing was cancelled. As a result of that early experience he was afraid he had had a prejudice against such devices. He thought, however, that not only the Society, but the Allied nations of the world owed a debt of gratitude to Lieut.-Commander Wilkinson for the excellent work he had done. He and Lieut.-Commander Wilkinson had worked together in this matter, and although he (the speaker) had not always been able to agree with him, he was quite sure that a tremendous amount of good had been accomplished. The greatest trouble they had in America was that there were too many schools, and each artist or inventor swore that his was the one and only school. They were consequently camouflaged themselves in trying to determine what process to follow, and he thought that Lieut.-Commander Wilkinson did more than any other man to separate the sheep from the goats and get them into an agreed line. A good deal of time and money was spent on trying to secure invisibility, which was ultimately discarded in favour of the dazzle painting. He could go a long way with Lieut.-Commander Wilkinson on some of these points, but he was never able to follow him right through to the same conclusions. It seemed to him that one of the serious drawbacks was that while the process confused the eye, it did not confuse the azimuth circle; one might not be able to see the course of the ship, but by taking two lines of bearing in the ordinary way it could be arrived at. As to the German side of the subject, two contradictory views on the effect of dazzle painting appeared to have been current in Germany, one that dazzle painting did not bother the submarines at all, and the other that it did—especially at night! He rather questioned the seriousness of the confusion in the case of a single ship; in the case of a convoy the matter was different. At the same time they would all admit that when the instruments were put to work, such as the azimuth circle, or instruments of greater refinement, the value of the camouflage was materially reduced. The German submarines which surrendered at Harwich showed some of the enemy schools of thought with regard to this defence. But the majority of them had adopted the ordinary war grey with some slight modification here and there. There were, however, a few which followed the Chinese junk system, and had everything, from an evil eye on the bow to ordinary camouflage. As he had not had the advantage of reading the paper before the meeting, he was afraid he could not add more to the discussion, but he would like to repeat that the Allied countries, particularly Great Britain, France, and America, owed Lieut.-Commander Wilkinson a debt of gratitude.

MR. FRANK HOULDER said that he would like to tell the Society one thing which occurred to him. In September 1918 one of his firm's new ships on the Clyde was camouflaged. He went out to her on a tug, and presently he said, "Where's the ship?" They told him, "Why, there she is!" And when he looked the only thing he could be sure of was that it was not a ship!

MR. W. G. RAFFÉ said that he wished the author would apply his talents to the de-camouflaging of London. Various committees working on the housing question might do worse than invite Lieut.-Commander Wilkinson to restrict (or help, if they preferred) the activities of the bill-posters which disfigured the streets. He did not need to remind them that the streets in German cities were much more tidy than in ours, largely because bill-posting was restricted. Someone had said that the best place for posters was on the Underground; and there he would have 10 per cent. of the posters displayed on the platforms and the remainder posted about halfway between the stations! Seriously, some considerable help might be afforded if they reflected that camouflage was the exact antithesis of publicity. The same principles which had served for camouflage would, applied reversely, hold good for publicity. A scientific restriction of bill-posting—the same for all—would benefit both advertisers and the public. The Chairman had expressed some difficulty over the word "camouflage." The word arose out of Parisian theatrical slang, and the general meaning was "disguise," so that it had preserved its meaning in the new setting. Parisian actors talked about "putting on the camouflage."

THE CHAIRMAN proposed a vote of thanks to Lieut.-Commander Wilkinson, which was passed unanimously.

LIEUT.-COLONEL ALLAN J. C. CUNNINGHAM writes:—Referring to questions raised as to origin and meaning of the word "camouflage," after the paper of February 11th, I think the following is worth publishing:—

Re Camouflage.—The "Dictionnaire International Français-Anglais," by MM. H. Hamilton and E. Legros, Paris, 1880, gives—

"CAMOUFLET (Lat. *Calamo flatus*). 1. Smoke puffed in the air in the face of a person asleep. 2. Fig. (mystification), affront. 3. (mil. eng.) Camouflet, stifler."

PRODUCTION OF FIGS IN SPAIN.

Among the various fruit crops of Spain a prominent place must be assigned to the fig, because of its widespread cultivation throughout the

peninsula, and its general use as a food product. In a number of the provinces the fig leads all other fruits in importance. The dried fruit serves as food for a large portion of the poorer classes, and in years of great abundance it is also used for fattening pigs for the local markets.

In the report of a national survey of fruit-bearing trees made by the Government agronomists a few years ago, of a total of twenty-one varieties of fruit trees considered, the fig was assigned the fifth place of importance with regard to the value of the crop, being surpassed only by the orange, the almond, the algarroba (carob) and the chestnut, in the order named. Of the forty-eight provinces of Spain the fig was assigned the first place of importance among fruit trees by two provinces, and the second place by seven.

The fig tree grows throughout Spain, but reaches its highest development in the extreme south of the peninsula, where the climate is mildest, and in the Balearic Islands. At the time of the survey referred to, the Province of Murcia, on the Mediterranean coast, possessed the largest number of trees, 1,636,800, and produced a crop valued at about £157,000. The Balearic Islands followed with a total of 778,640 trees, and an estimated crop valued at about £47,000, Malaga Province coming next with 699,400 trees, and a crop estimated to be worth £92,000.

Although the survey was made nearly ten years ago, writes the United States Consul at Barcelona, there has been no considerable increase in the number of fig trees since that time, so that the figures arrived at by the survey can be accepted as showing the approximate status of fig-growing in Spain at the present time. According to this survey there were in Spain in 1910, 5,105,500 fig trees, of which number 1,272,960 were in regularly planted and cultivated orchards. The total area of these orchards amounted to 20,718 hectares (approximately 51,200 acres). The total production of figs during that year was 1,494,789 metric quintals (of 220·4 lb. each) valued at 15,310,883 pesetas (about £612,000). Owing to its hardiness only about one-fourth of the total number of fig trees is found in regularly planted commercial orchards, and very rarely is the fig tree given a place in the valuable irrigated lands. In the few cases in which the fig tree is planted in orchards it is set out 8 or 10 metres apart, while the spaces between the trees are closely cropped to vegetables or small grain, which is given the usual intensive cultivation employed in Spain.

The scattered fig trees receive very little care, and seem to require little except hoeing around the base of the tree in the spring and the removal of the dead branches. The Spaniard has a saying that the fig tree begins to bear at three years of age and lives for ever.

A number of the varieties of the fig tree in Spain produce two separate and quite distinct crops. The first crop matures during the months of June and July, and consists of a fruit known as the "breva," which has little market value, for it is quite perishable and cannot be dried as the regular fig of the later crop. It is pink in colour and about the same size and shape as the regular commercial fig, but very inferior to it in quality.

The second and much more important crop ripens during the months of July, August and September, and it is from this crop that the ordinary dried fig of commerce is obtained. As the fruit is sun-dried it is necessary that the picking be done only on clear, sunny days. The fruit is taken from the trees, spread upon mats made of a species of cane, and left in the sun to dry from ten to twelve days. During this period the fruit requires little attention, except turning every two or three days for more uniform drying. When it is properly dried it is carried in baskets to specially prepared sheds, in the case of large orchards, or to the owner's house or such other suitable place as may be available, and there is carefully graded as to size, colour, etc. It is then flattened out by hand and placed in rows in boxes for shipping. Those intended for export are packed in boxes of 10 kilos (22 lb.) each, and fruit for the domestic market in boxes of 25 kilos, or in small locally woven containers holding about 1 kilo.

The exports of dried figs from Spain during the years 1916–18 were 22,072,358 lb., 44,244,800 lb., and 34,194,200 lb. respectively.

COHUNE-NUT INDUSTRY IN HONDURAS.

Practically nothing had been done towards developing the cohune-nut industry previous to the world war. With the demand for combating the use of poison gas in the war, it was found that the shell of the cohune nut, when carbonised, acted as a preventive against the injurious effects of the gas. It therefore became the principal element used in the manufacture of the gas mask. There was, of course, need for millions of these, and the United States Government organised and set in motion the machinery for handling the industry on a large scale; but with the termination of the war the demand ceased. The utilisation of the cohune nut for war purposes, however, writes the United States Consul at Ceiba, served to encourage an industry which may be permanent, viz. the extraction of oil from the kernel of the nut.

The cohune (or corozo) nut is a product of the manaca palm, is indigenous to tropical countries, and is found mostly on low, damp lands, along creeks and rivers. It thrives best in the deep forest, and the greatest supply is found in virgin forest lands, of which there are extensive areas in Honduras.

The nuts grow in large oblong clusters, weighing probably 75 lb. each. A single tree will have from one to four clusters on it at a time, and with an average production of four clusters (300 lb.) a year to the tree. The nut varies in size from 1½ to 3 inches in length, and from 1 to 2 inches in diameter. The shell is hard and dense, with an

average thickness of ¼ to ½ inch. For cracking the nuts preparatory to extracting the oil, two varieties of machines are used. One is designated a "knuckle" machine, in which the nuts drop from a hopper between heavy knuckles, thus cracking the shell. The other is called an "impact" machine. It operates by a centrifugal motion, which propels the nut against the side of a large metal bowl with sufficient force to break the shell. The oil can then be extracted from this copra or crushed product.

The oil is high grade, said to be superior to coconut oil, and finds a ready sale for cooking purposes, the preparation of foods, or any use to which a good cooking oil may be put.

Honduras is said to be at present the most important source of cohune nuts in Central America. The greatest supply is found on the lowlands toward the eastern portion of the north coast. The Aguan River valley contains a single field of these nut-bearing trees extending sixty to seventy miles up the river from its mouth and with an average width of ten to twelve miles. Persons familiar with the industry who have been over this field estimate that an equipped force of 500 men could get 10,000 tons of nuts a month from this field alone. There are good prospects, adds the United States Consul, of this valley being reached by railway in the near future, thus furnishing transportation facilities for the development of the industry.

LACE INDUSTRY OF THE CHEFOO DISTRICT.

The art of lace-making was first taught to the Chinese of the Chefoo district by foreign missionaries twenty-five years ago. They believed that by teaching lace-making the women and girls would find profitable employment within their own homes, and the subsequent spread of the industry has fully justified their efforts. Although first taught in Chefoo, Chi Hsia Hsien was the first district in which lace was extensively made. The city of Chi Hsia, the centre of the district, is about thirty-five miles south-west of Chefoo. There torchon laces were first made of silk thread and found a limited retail market in the city of Chefoo.

In 1895 a British missionary established an institution called the Chefoo Industrial Mission and commercialised the lace industry. With a small beginning in local retail sales, retail exporting followed and gradually developed into wholesale transactions. About fifteen years ago, writes the United States Consul at Chefoo, the making of thread laces was introduced, and with the use of Belgian and French patterns Chefoo first entered into competition with European laces.

The original laces being made of silk, the industry was self-centred as Chinese-made silk-thread was used. After the introduction of thread laces both linen and cotton thread were imported exclusively from England. Owing to the war's interruptions supplies were irregular and at times ceased, and Japanese cotton thread entered the market.

Chi Hsia supplies fully 50 per cent. of the laces of the Chefoo district. The finest laces come from Ching Chou, which is thirty miles west of Weihsien. This city markets its lace largely through Chefoo. The Ching Chou laces are the closest patterns made in Shantung Province, some requiring more than 300 bobbins in their manufacture.

The principal kinds of lace manufactured in the district are Torchon and Cluny, the former being marketed mainly in Australia, and the latter in America. In addition a small quantity of filet lace, a new kind for the Chefoo district, is made, and imitation Maltese lace is also turned out to a limited extent.

Torchon and Cluny laces were originally made in this district according to the general method of making bobbin lace by hand; that is, fastening the design on a specially constructed cushion, inserting pins at the points of intersection, and passing the bobbins back and forth in front of the pins according to the design and the kind of lace being made. An improvement was later made by using a cylinder approximately three inches in diameter which revolves above a flat board on which the bobbins rest, in place of the cushion. The pattern is attached to the cylinder so that when it is revolved the design is continuous. In this way the pins are removed and advanced as required, and the finished lace passes over the back of the cylinder. Under the former system, the design being of limited length, it was necessary to remove all the pins and shift the unfinished end of the lace to the top of the design in order to continue the work. In the Ching Chou district lace is still made in the old way on cushions.

Filet lace is made by using a knitted mesh which is stretched over a frame, the pattern being embroidered with a needle.

The number of bobbins used in making lace varies from 8 to over 500, according to the kind and the design. The simplest patterns of Cluny laces of narrow width require the minimum, whereas wide torchons of intricate design require the maximum. As more than 300 different designs and widths of torchons and Cluny laces are made in the Chefoo district, it is difficult to use a standard by which comparisons may be made. Generally, a yard of torchon, 1 inch in width, requires from 28 to 40 bobbins of thread, the number being governed by the design, whereas from 36 to 44 bobbins are required to make a yard of Cluny lace 1 inch wide.

There are from 30 to 50 yards of thread on a bobbin, depending on the size of the bobbin, which, being crudely made by local carpenters, varies considerably, and the number of the thread used. Although the amount of thread used in making lace slightly varies the cost, the main difference is governed by the number of bobbins necessary to make a given pattern. The bobbins are wound by hand.

Until the European war upset trade conditions, English thread was used almost entirely in the

Chefoo lace-making industry. The war, however, as mentioned above, enabled threads of Japanese manufacture to enter into serious competition with those of English make in the local market. Lace made from Japanese thread, although its initial appearance is satisfactory, is, says the United States Consul, defective in wearing qualities, and after being washed the strands of the thread separate and the lace becomes uneven and loose.

Thread is distributed to the workers by native brokers who pay for the labour and collect and sell the finished lace to the exporters. The work is done in the homes of the lace makers and payment is made by the yard according to the number of bobbins used, the kind of lace, and the pattern. A skilful worker, devoting an entire spring day, can complete 2 yards of torchon lace 1 inch in width for which she will receive 500 cash (about one shilling) for her labour.

Laces are graded into three classes. Those falling below the third quality are rejected by responsible exporters and disposed of as job lots. Qnality is governed, in addition to the different kinds of thread, by workmanship, cleanliness, firmness, and evenness of pattern. Cleanliness is most important as the lace cannot be washed before it is sold. Considerable skill is required to grade laces, as only an expert can judge what the appearance will be after wear and washing.

CORRESPONDENCE.

CONFERENCE ON HOUSE FURNISHINGS.

May I correct an error in your report of my remarks in the discussion at the "Conference on House Furnishings"?

I am reported as saying that "there was not a single cottage in the Exhibition suited to the taste or purse of a cottager." What I really said was "there was not one cottage *furnished* for the needs of a cottager." I should also like to add that if furniture designers and makers would only realise the truth that good proportions, good lines, and pleasant colour, cost less than bad ones and unpleasant colour; and if the public would look for essentials in furniture rather than showy, useless features, we should have the cheaper types of furniture brought out of the "nasty period," so aptly described by Mr. Bianco in his remarks on the more costly productions.

PERCY A. WELLS.

GENERAL NOTES.

INDIA'S FOREST RESOURCES.—On April 19th, 1917, a paper by Mr. R. S. Pearson, F.L.S., on "The Recent Industrial and Economic Development of Indian Forest Products" was read before the Indian Section of the Society. Sir Robert W. Carlyle, late Revenue and Agricultural Member of the Government of India, who presided on the occasion, referred to the possibility of very great developments, with a sufficiently adequate staff, more roads, and the best mechanical means of extracting the timber. In view of these problems the Government of India has recently decided to create a Forest Engineering Service, paid on the same scale as the Imperial Forest Service. It is proposed that the recruits to the new service should be trained in Canada and the United States, where, it is pointed out, the subject of timber extraction and utilisation has long been studied, and improved methods have been introduced under conditions approximating to those encountered in many parts of India and Burma.

SYNTHETIC DYES.—An article in the *Board of Trade Journal*, February 5th, points out that while there are many gaps in the range of dyes now being produced by British makers, the position is distinctly hopeful, and that there is every ground for the belief that the main difficulties inherent in the creation of so complicated an industry as the coal-tar chemical industry have been successfully surmounted. It took the Germans forty years to reach their present position, and it cannot be expected that we can attain the same position, even with the valuable stimulus of a five-year war period, in much less than ten to fifteen years. Hence the proposal for the temporary protection of the industry for a limited period. The present output of dyes in this country is not less than 25,000 tons per annum.

HOME-GROWN TIMBER.—It appears from an answer given to a question in Parliament that the sales of the Home-grown Timber Department last year approximated in value to £3,700,000. The Department, it was mentioned, is being wound up as rapidly as possible. There are still about 6,500 workpeople—sawyers, fellers, etc.—on its pay roll.

SOLID LUBRICANTS.—The Advisory Council of the Committee of the Privy Council for Scientific and Industrial Research have published a Memorandum on Solid Lubricants which has been prepared by their Lubricants and Lubrication Committee. This Committee was appointed in July 1917 to survey the field for research on Lubricants and Lubrication, and in the course of their work dealt with the question of Solid Lubricants. The Memorandum embodies existing knowledge on the subject, but the Advisory Council desire that the Bulletin should be regarded rather as a summary of existing literature than as an authoritative statement based upon actual research work. The subject is dealt with under the following main headings: (1) Characteristics of Solid Lubricants. (2) Action of Solid Lubricants. (3) Analyses of Lubricating Graphites. (4) The Grading of Graphite. (5) Hot Bearings. (6) Methods of Applying Solid Lubricants. (7) Drawbacks to the use of Colloidal Solid

Lubricants. (8) Observations on Results obtained by the use of Solid Lubricants. The Bulletin is published by H.M. Stationery Office and may be purchased through any bookseller, or directly, price 6*d*. net, from H.M. Stationery Office.

USE OF RARE SUGARS.—The so-called rare sugars are used to a considerable extent by the Army Medical Corps and by the medical profession in general. One of the principal uses to which they are put is the differentiation of bacteria, for which purpose they are invaluable. For some time the United States Bureau of Standards has had presented to it for test a number of these rare sugars. Owing to the large demand for one of these sugars, known as d-Mannite, the Bureau undertook, at the request of the United States War Department, the production of a considerable quantity of this substance. The source of supply is a crude manna. The Bureau's investigations finally developed a method whereby pure white crystals of d-Mannite can be produced by two crystallisations from the crude manna. It has thus become possible to produce relatively large quantities of this valuable substance at a reasonable cost.

EMPIRE TIMBER EXHIBITION. — An "Empire Timber Exhibition" will be held at the Holland Park Skating Rink from July 5th to July 17th. It is being organised by the Department of Overseas Trade with the primary object of bringing prominently before architects, inspectors, and firms required to specify timbers in their contracts, as well as before users and consumers, the full range of Imperial grown timbers, and especially those kinds which up to the present are only slightly, if at all, known in this country. It is also desired at the same time to demonstrate the chief uses for which such timbers are suitable. Almost all the self-governing Dominions, Crown Colonies, and Protectorates have definitely decided to participate. A limited amount of space will be available for the use of traders in this country in which to display specimens of articles manufactured from timbers grown within the British Empire.

MEETINGS OF THE SOCIETY.

ORDINARY MEETINGS.

Wednesday afternoons, at 4.30 p.m.:—

MARCH 17. — WILLIAM WORBY BEAUMONT, M.Inst.C.E., "Street Passenger Transport of London." KENNEDY JONES, M.P., Chairman, Select Committee on Transport (Metropolitan Area), will preside.

MARCH 24.—L. GASTER, "Industrial Lighting in its relation to Efficiency." SIR HENRY TRUEMAN WOOD, Chairman of the Council, will preside.

APRIL 14.—JOSEPH THORP, "The Fundamental Basis of Good Printing."

APRIL 21.—AIR-COMMODORE EDWARD MAITLAND, C.M.G., D.S.O., A.F.C., "The Commercial Future of Airships."

APRIL 28.—CHARLES H. SHERRILL, "Stained Glass."

MAY 5.—DR. C. E. KENNETH MEES, "A Photographic Research Laboratory." SIR HENRY TRUEMAN WOOD, Chairman of the Council, will preside.

MAY 12.—

MAY 19. — JOHN SOMERVILLE HIGHFIELD, M.Inst.C.E., M.I.E.E., "Electrical Osmosis."

INDIAN SECTION.

Friday afternoon, at 4.30 p.m.:—

MARCH 19.—SIR WILLIAM S. MEYER, G.C.I.E., K.C.S.I., Financial Member of Council of the Governor-General of India, 1913-18, "The Indian Currency System and its Developments." THE RIGHT HON. LORD CHALMERS, G.C.B., LL.D., will preside.

Thursday afternoons, at 4.30 p.m.:—

APRIL 15.—BRIGADIER-GENERAL LORD MONTAGU OF BEAULIEU, C.S.I., "Roads and Transport in India."

MAY 20.—SIR GEORGE CUNNINGHAM BUCHANAN, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

Monday afternoon, at 4.30 p.m.:—

MAY 31. — ALBERT HOWARD, C.I.E., M.A., A.R.C.S., F.L.S., Imperial Economic Botanist to the Government of India, "The Improvement of Crop Production in India." SIR ROBERT W. CARLYLE, K.C.S.I., C.I.E., will preside.

Date to be hereafter announced:—

SIR VALENTINE CHIROL, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

COLONIAL SECTION.

Tuesday afternoon, at 4.30 p.m.:—

MAY 4.—PROFESSOR WILLIAM A. BONE, D.Sc., Ph.D., F.R.S., "Lignite."

INDIAN AND COLONIAL SECTIONS.
(Joint Meeting.)

Friday afternoon, at 4.30 p.m.:—

JUNE 4. — PROFESSOR SIR JOHN CADMAN, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E., "The Oil Resources of the British Empire."

Dates to be hereafter announced:—

GRAILY HEWITT, "Rolls of Honour."

CHARLES CROWTHER, "The Arts and Crafts

of Japan" (with examples from the author's private collection).

WILLIAM CRAMP, D.Sc., M.I.E.E., "Pneumatic Conveying Plants, with special reference to the Transport of Grain."

CANTOR LECTURES.

Monday evenings, at 8 p.m.:—

WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.

May 3, 10, 17.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MARCH 15...Chadwick Public Lecture, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.15 p.m. General Sir John Goodwin, "Military Hygiene in Peace and War." (Lecture II.)

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Mr. E. W. G. Masterman, "The Walls of Jerusalem at Various Periods."

Surveyors' Institution, 12, Great George-street, S.W., 8 p.m. Mr. T. H. Bailey, "The Third Report of the Acquisition and Valuation of Land Committee on the Acquisition for Public Purposes of Rights and Powers in Connection with Mines and Minerals."

Geographical Society, 135, New Bond-street, W., 8.30 p.m. Professor J. L. Myres, "The Dodekanese."

East India Association, 3, Victoria-street, Westminster, S.W., 3.45 p.m. Mr. N. N. S. Gupta, "The Agricultural Development of India."

British Architects, Royal Institute of, 9, Conduit-street, W., 8 p.m. Mr. H. A. Hall, "The Planning of American Departmental Stores."

TUESDAY, MARCH 16...Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.30 p.m. Messrs. M. A. Ockenden and A. Carter, "Plant used in the Rotary System of Drilling Oil Wells."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. Keith, "British Ethnology: the Invaders of England." (Lecture III.)

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. Sir Alexander Kennedy, "Exhibition of Lantern Views taken throughout the War Areas in France and Flanders."

Anthropological Institute, 50, Great Russell-street, W.C., 8.15 p.m. 1. Surgeon-General R. Buddle, "Exhibition of Flint Implements from Russia." 2. Mr. N. W. Thomas, "The Ovia Secret Society."

Zoological Society, Regent's-park, N.W., 5.30 p.m. 1. Mr. R. I. Pocock, "On the External Characters of South American Monkeys." 2. Dr. C. F. Sonntag, "The Comparative Anatomy of the Tongues of the Mammalia. I.—General Description of the Tongue."

WEDNESDAY, MARCH 17...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. W. W. Beaumont, "Street Passenger Transport of London."

Aeronautical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Major C. F. Abell, "Airship Machinery: Past Experience and Future Requirements."

Meteorological Society, at the Royal Astronomical Society, Burlington House, W., 5 p.m. Captain C. K. M. Douglas, "Clouds as seen from an Aeroplane."

United Service Institution, Whitehall, S.W., 3 p.m. Major H. F. S. Huntington, "The Physical and Ethical Value of Boxing."

Electrical Engineers, Institution of (Wireless Section), at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Captain P. P. Eckersley, "Duplex Wireless Telephony: Some Experiments on its Application to Aircraft." (South Midland Section.) The University, Birmingham, 7 p.m. Major K. Edgcumbe, "The Protection of Alternating Current Distribution Systems without the Use of Special Conductors."

Industrial League and Council, Central Hall, Westminster, S.W., 7.30 p.m. Discussion on "Our League: how can we improve it."

THURSDAY, MARCH 18...Cold Storage and Ice Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m.

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. Dr. J. Small, "The Chemical Reversal of Geotropic Response in Roots and Stems."

Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. I. Masson and R. McCall, "The Viscosity of Nitrocellulose in Mixtures of Acetone and Water." 2. Messrs. H. Stephen, W. F. Short, and G. Gladding, "The Introduction of the Chloromethyl Group into the Aromatic Nucleus." 3. Mr. H. E. Cox, "The Influence of the Solvent on the Velocity of Reaction between certain Alkyl Iodides and Sodium β-naphthoxide." 4. Messrs. H. Crompton and P. L. Vanderstichele, "The Use of 1:2 Dichlorvinylethyl Ether for the Production of Chloracetates and Acid Chlorides."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. S. Graham, "The Spirit of America after the War." (Lecture I.)

Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m. Mr. C. Crowther, "Things Japanese."

Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Discussion on papers:—1. Mr. W. H. Patchell, "Notes on Operating a By-product Producer Gas Plant for Power and Heating." 2. Mr. S. H. Fowles, "Production of Power from Blast Furnace Gas."

Numismatic Society, 22, Russell-square, W.C., 6 p.m.

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, W., 5.30 p.m. Mr. W. R. Jones, "Tin and Tungsten Deposits: The Economic Significance of their Relative Temperatures of Formation."

FRIDAY, MARCH 19...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Sir William S. Meyer, "The Indian Currency System and its Developments."

Royal Institution, Albemarle-street, W., 9 p.m. Mr. E. McCurdy, "Leonardo da Vinci."

Concrete Institute, 296, Vauxhall-bridge-road, S.W., 6 p.m. Dr. O. Faber, "Notes on the Practical Applications of Reinforced Concrete."

SATURDAY, MARCH 20...Royal Institution, Albemarle-street, W., 3 p.m. Professor Sir J. J. Thomson, "Positive Rays." (Lecture V.)

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FRIDAY, MARCH 19, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

Wednesday, March 24th, at 4.30 p.m. (Ordinary Meeting.) L. Gaster, "Industrial Lighting in its Relation to Efficiency." Sir Henry Trueman Wood, Chairman of the Council, will preside.

FOURTEENTH ORDINARY MEETING.

Wednesday, March 17th; Mr. William Kennedy Jones, M.P., Chairman of the Advisory Committee on London Traffic, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Barker, Frederick Walter, London.
Barnsley, Frank Herbert, Dudley.
Burlin, Adolph L., Ph.D., Manchester.
Butterworth, Charles Frederick, Poynton, near Stockport.
Corker, James S., Manchester.
Farrar, George Edward, Richmond, Surrey.
Hoffman, Frederick L., LL.D., Newark, New Jersey, U.S.A.
Lomas, Leslie H., B.Sc., Prestbury, Cheshire.
Oxley, Ernest C. F., Sioux Lookout, Ontario, Canada.

The following candidates were balloted for and duly elected Fellows of the Society:—

Crook, Charles W., B.A., B.Sc., London.
Ford-Moore, Lieut.-Colonel A. P., London.
Frazer, E. D., London.
Hough, Lynn Harold, Evanston, Illinois, U.S.A.
Howes, George Henry, Wallington, Surrey.
Parnell, Edward, Sarawak, Borneo.
Richards, Herbert Edward, Marlow.
Tonamy, Chika Hira, Fushimi, Kyoto, Japan.
White, Edmond Aunger, Port Kembla, New South Wales, Australia.

A paper on "Street Passenger Transport of London" was read by Mr. William Worby Beaumont, M.Inst.C.E.

The paper and discussion will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

TENTH ORDINARY MEETING.

Wednesday, February 18th; Mr. Neville Chamberlain, M.P., in the chair.

The paper read was—

ENGLISH CANALS AND INLAND WATERWAYS.

By Sidney Preston, C.I.E.

The question of transport has been much to the fore during the past year, and the canals of the country are of some considerable importance in this consideration. This probably accounts for my having been asked to read a paper before this Society on them. You will notice that I have called the paper "English Canals and Inland Waterways." I have done this on purpose, as I have had nothing to do with those in Scotland, and have seen nothing of those in Ireland.

The canals in England divide themselves into two main groups, namely, those that are owned or controlled by railway companies and those that are owned and controlled by independent companies or bodies. Early in the war the independent canals began to be seriously depleted of their staff and the boatmen trading on them, so that there was serious risk of many of them having to be closed down for want of men. Moreover, the great increase in wages, prices of material, etc., had so increased the maintenance and working expenses that it was proving impossible for the companies to carry on at their statutory rates and tolls in competition with the railway freight rates, which at that time had not been increased.

It was therefore decided by Government to take over the control of the main arterial lines, and this was done from March 1st, 1917. Subsequently, some carrier companies also came under control.

It is not necessary to say much about the Canal Control Committee, as it was a war measure, but it is mentioned as for the moment it introduces a new category into the canal system, which may be now classified as follows:—

1. Railway owned or controlled.
2. Controlled by Government.
3. Independent.

The Control Committee assisted the canals in the following ways :—

1. Issued cards protecting men over twenty-five years of age from military service.

2. Agreed to pay a war bonus to the establishment employed.

3. Supplemented the depleted staffs by men from Transport Workers' Battalions.

4. Assisted the companies to obtain necessary material or priority orders for work.

5. Negotiated for the return of men who had been in their employ.

6. Controlled the sale and transfer of canal boats.

7. And most important—it guaranteed to the companies the net revenue they earned in a standard year, which in most cases was 1913.

The amounts of compensation paid on the English canals alone has been :—

In 1917	£410,300
,, 1918	748,038
,, 1919 (approximate) . .	994,494
	£2,152,832

Besides this, the following compensation was also paid to the carrying companies who came under control :—

In 1917	£9,678
,, 1918	36,549
,, 1919 (approximate) . . .	53,284
	£99,511

making a total of £2,253,343.

It is extremely difficult to find anything to say about canals which has not been said time after time. Generally it is correct to say that they are in exactly the same condition as they were when originally constructed towards the end of the eighteenth century, and the early part of the nineteenth century. Then came the beginning of the railway era, and canals passed into the background and to a large extent came under the control or ownership of railway companies.

It seems to me that, instead of detailing the numerous disabilities from which the English canal system suffers, it may serve a useful purpose to refer to the numerous endeavours which have made been in the last forty years to get some improvement made in it. For this purpose I will start with the Select Committee which was appointed on February 22nd, 1883, "to inquire into the conditions and the position of the canals and internal navigations of the country, to report thereon, and to make such recommendations as may appear necessary."

The original Committee consisted of fifteen members, one of whom was discharged on April 26th, 1883, while two more had been added on April 18th. Thus the Committee really consisted of sixteen members.

On May 21st, 1883, the Canal Boats Act (1887) Amendment Bill was read a second time and committed to the Committee.

This Committee held eleven sittings and examined the following witnesses :—

1. Mr. H. G. Calcroft, Assistant Secretary, Railway Department, Board of Trade.
2. Mr. E. J. Lloyd, Engineer and Manager, "Warwick" Canals.
3. Mr. W. H. Bartholomew, Engineer, Aire and Calder Canal.
4. Mr. James Abernethy, President, Institute of Civil Engineers.
5. Mr. W. Evans, solicitor to Birmingham Canal Navigation.
6. Mr. J. Allport, Manager, Midland Railway.
7. Mr. J. S. Watson, iron steam-barge builder, Blackwall.
8. Mr. W. B. Clagram, Engineer and Superintendent, Sharpness New Docks and Gloucester and Berkeley Canal.
9. Mr. Thorpe, partner in Barkworth & Spalding, of Hull and Gloucester, timber and slate merchants.
10. Mr. J. H. Taunton, engineer and manager, Thames and Severn Canal.
11. Mr. F. R. Conder, M.Inst.C.E.
12. Mr. S. F. Vernon Harcourt, C.E.
13. Mr. F. Morton, of Fellows Morton & Clayton, canal carriers.
14. Mr. J. Hunt, canal carrier, of Leeds.
15. Right Hon. Sir H. Bartle Frere.
16. General F. Rundall, R.E.
17. Mr. G. Smith, of Coalville.
18. Right Hon. Sir F. Peel, Chairman, Railway Commissioners.
19. Mr. C. F. Clark, ironfounder, Wolverhampton.
20. Mr. F. S. Powell, Chairman, Canal Association.

In addition to the verbal evidence given by these witnesses many notes and statistical tables were put in, all of which are published with the report of the Committee.

Thus much useful information was collected, but the Committee came to no conclusion, nor did it make any recommendations, its report, which was dated July 12th, 1883, being in the following terms: "Your Committee have examined several witnesses upon the subject and upon the Bill referred to them, but as it will not be in their power to conclude the investigation in the present session, they have agreed to report the evidence already taken before them and to recommend that the Committee should be reappointed in the next session of Parliament." The Committee also agreed to report the Canal

Boats Act (1877) Amendment Bill without amendment.

The Committee was not reappointed. It will be seen that the list of witnesses includes canal and railway engineers, and managers, boat builders, traders, canal carriers and independent men, and it is much to be regretted that the time spent and information obtained led to no practical result.

In 1884 General Rundall, R.E., read a paper before this Society, in which he enumerated the advantages and defects of canal carriage as follows:—

Advantages:

1. Goods can be carried in the most economical manner suited to them, without interference with any other class.

2. Boats can load and unload at any point, and can receive or discharge cargoes from or to ships direct.

3. Dead weight to be moved, in proportion to the load, is a minimum.

4. Capacity of canal for traffic is practically unlimited, if locks properly designed.

5. No obligation on canal company to provide expensive plant, as boats will be provided by traders.

6. Almost total absence of risk to cargoes, therefore insurance is a minimum.

The defects are:

1. Absence of unity of management.

2. Want of uniformity in gauge of the canals and locks.

3. With few exceptions, not capable of being worked by steam.

4. Unequal system of tolls.

5. So many links in the communications being in the hand of railways.

On May 10th and 11th, 1888, this Society held a conference on the Canals and Inland Waterways, when the following papers were read and discussed:—

1. Canal Engineering, its Past, its Present Aims, and its Prospects in the Future, by S. F. Vernon-Harcourt, M.A.

2. History, Rise and Progress of Canal and River Navigation in Great Britain and Ireland, by M. B. Cotsworth.

3. History of the Rise and Progress of Waterways and Railways in England and Wales, and their Mutual Influence on each other, by W. A. Forbes.

4. Inland Navigation in Great Britain, by E. J. Lloyd.

5. Present Condition of Inland Navigation in the United Kingdom, with Suggestions for its Improvement, by M. B. Cotsworth.

6. Inland Transport in the Nineteenth Century by Land and Water, by F. R. Conder.

7. Transport by Canals and Railways, by G. Lester.

8. Canals and Inland Navigations properly National Works, by General Rundall, R.E.

9. Some Remarks on the Canals and Inland Navigations of France, Belgium and Holland, by W. J. C. Moens.

10. Improvements in Canal Communication, by Samuel Lloyd.

11. Inland Transport a New Departure, by S. Lloyd.

12. Relative Cost of Transport by Railway and Canal, by W. Shelford.

13. Water Transport, by Colonel W. M. T. Campbell.

Besides these there were special articles on:—

14. Canals and Shallow-draft Steam Navigation of Canal.

15. River Weaver Navigation.

16. Kennet and Avon Canal.

17. Improvement of the Water Communications between London and Birmingham.

18. Maintenance of Canals in Mining Districts.

19. Capabilities of the River Severn as an Inland Navigation.

20. The Laws of Canals.

It will be noticed that many of the papers were contributed by men who had given evidence before the Select Committee in 1883.

The first thirteen papers contain a complete history of the growth of the canal system, set out their many defects, indicate in what way they might be improved to become of greater national importance and usefulness, discuss the much vexed question of the effect on water communication of the ownership or control of canals by railway companies, point out the urgent necessity for the unification of the standard dimensions of canals, the necessity for the elimination of the numerous small companies, and discuss the advantages of State ownership.

The last seven papers deal with individual waterways, and are not so interesting for my purpose, except perhaps the one about the improvement of water communication between London and Birmingham. It would be impossible, in the time at my disposal, adequately to summarise all the papers; but I venture to think that at this time, when the fate of the canals of the country will shortly be under the consideration of the Ministry of Transport, it may be of value to bring these papers prominently to light. They are all written by men keenly interested in water transport, and I

would suggest that if the Society has still a few copies left of the pamphlet it published as a result of the conference, they could not be put to better use than to be transferred to the new Ministry for the perusal of those who will have the deciding of the general question regarding the future of inland navigation. As far as I can judge, the case for water communication is put as strongly as possible, and it will be for the Ministry to decide whether the arguments are sound or not.

You may wonder what results were obtained from this conference? As far as I am aware none whatever.

The next move was the appointment of the Royal Commission on Canals and Inland Navigations of the United Kingdom. This Commission was apppointed on March 5th, 1906.

The terms of reference were as follows:—

To Inquire into the Canals and Inland Navigations of the United Kingdom, and to report on:—

1. Their present condition and financial position.

2. The causes which have operated to prevent the carrying out of improvements by private enterprise, and whether such causes are removable by legislation.

3. Facilities, improvements and extension desirable, in order to complete a system of through communication by water between centres of commercial, industrial, or agricultural importance, and between such centres and the sea.

4. The prospects of benefit to the trade of the country, compatible with a reasonable return on the probable cost.

5. The expediency of canals being made or acquired by public bodies or trusts, and the methods by which funds for the purpose could be obtained and secured, and what should be the system of control and management of such bodies or trusts.

The report of this Commission may, indeed, be said to be a monumental work in eleven volumes. These contain three interim reports, issued on November 26th, 1906, October 30th, 1907, third Report October 12th, 1909, and a fourth and final report of the same date.

It will be interesting to see briefly what the recommendations in the main report were, and what were the reservations or qualifications in the subsidiary memoranda. Its recommendations were:—

1. The appointment of a Central Waterways Board for Great Britain.

2. The four main routes generally spoken of as "the Cross" to be vested in the Board, to whom the administration of all waterways vested in them should be entrusted.

3. That if for financial, or other reasons, the larger works of improvement recommended have to suffer some postponement, the unification of these waterways and the transfer of their administration to the Waterways Board should be effected without delay. This was considered most important, especially if accompanied by minor improvements and some reduction of tolls on unification.

4. The Waterways Board to review the whole situation on the lines of practical business with special regard to finance and benefit to trade and public interest, to the extent of local assistance, prospect of traffic and to competition of railways. It should prepare schemes for submission to Parliament.

5. It should propose further schemes from time to time when satisfied of the expediency of acquiring and unifying any further waterways, either as branches or feeders.

6. The acquisition of waterways now in the hands of railway companies should be included in the earlier schemes.

7. It is worthy of consideration whether the collection of information as to the flow of rivers and streams and as to water supplies in Great Britain, where there are navigable waterways, should not also be entrusted to the Waterways Board.

8. The Commission indicated the financial assistance the State should give for the acquisition and improvement of the waterways forming "the Cross."

There were many other recommendations, but it is impossible to mention them all in this paper.

The Commission consisted of nineteen members, all of whom signed the report except Messrs. J. F. Remnant, R. C. H. Davison and J. C. Inglis, who put in reports of their own; while Lord Farrer, Sir John Wilson, Mr. Waldron and Mr. Killick put in a memorandum and reservations on the report; Lord Farrer attached an additional note, and Mr. Russell Rea put in a memorandum of reservation.

It would be well to state briefly what were the reasons for the dissent of three members of the Commission and the additional notes and reservations of others. Mr. Remnant considered the report inconclusive, thought the inquiry they had made was sufficient to enable a final decision to be formed on the questions raised by the terms of reference, and was of opinion the evidence did not warrant any steps

being taken in the direction indicated by the report so long as the main factors then governing the transport of goods in this country continued to operate. On the main heads of the inquiry his opinion was :—

1. That the canals are a declining industry, being replaced by the cheaper and more expeditious railways. That the tendency of traders is to hold small stocks, relying on quick replenishments, and this would militate against the larger 100-ton barges advocated.

2. That the State would not be justified in finding capital to bolster up an obsolete system.

3. The cost of the scheme advocated would be enormous, and there was no evidence to show that trade would use it. It seemed likely the probable cost has been underestimated.

4. It was inadvisable that a board should be formed to acquire, administer or deal with the waterways.

Mr. Davison agreed with the report that any controlling authority should not become carriers, as the State should not compete with the privately-owned railways. He did not think the circumstances of the English canals were similar to those on the Continent. He questioned whether the 100-ton consignments will suit the present system of trade, and considered further information was necessary on financial points, while he questioned the accuracy of the traffic estimate. Generally, he considered railways more efficient, and that the State should not subsidise a decaying industry. Mr. Inglis, who was Chief Engineer of the Great Western Railway, considered this country really unsuitable for canals, owing to its configuration, and that the system is obsolete; that the State should not subsidise a decaying industry against railways, the capital for which was raised privately. The scheme proposed would favour works situated on the canals at the expense of those not so situated. He contended that no analogy could be drawn from the success of the Continental canals, and that we should not attempt to copy them. He considered the estimates of cost and traffic unreliable and incomplete in many items that he specified. He thought the setting up of a system of State-aided canals would arrest railway development, and that any State aid must be given to all forms of transport alike.

Lord Farrer took exception to the proposition that it is the business of the State to provide the best and most economical mode of transport if private enterprise failed to do it, as he held that this was favouring certain traders at the expense of others.

Mr. Russel Rea, though signing the report, objected to the recommendations that the Rivers Trent and Severn should be improved so as to pass boats of 750 tons to Nottingham and Worcester, and of 600 tons to Stourport. He objected on two grounds :—

1. Because he thought the 100-ton gross scheme a sufficient programme to engage the attention of a Waterways Board.

2. He had no confidence in the utility or prospects of any return from them.

The memorandum by Lord Farrer, Messrs. Wilson, Waldron and Killick, took exception to the proposition in the report that it is the duty of the State to provide cheap transport to inland districts. It stated that the report was based on the underlying assumption that improved waterways would supply cheap transit as compared with railways. In regard to this, they thought there were some general considerations which should be stated. Thus, water carriage by sea is undoubtedly cheaper than any other method of transport, the reasons being :—

(*a*) The existence of an ample waterway open to all carriers free of charge.

(*b*) The enormous reduction of the effort of traction necessary to remove a given weight as compared with other methods.

They held that the benefit this affords can only be obtained so far as, and in proportion to, the extent to which similar conditions can be created. They admitted that to a certain extent these advantages are obtainable on Continental waterways, but maintained that the economic conditions of France, Belgium and Germany cannot be reproduced in England. They could not agree that because it is not proposed that the State should become carriers the objection of State improvement of waterways is removed or diminished, and that therefore the question of the State improving inland navigation to compete with privately-owned railways requires further consideration. The evidence laid before the Commission had not satisfied them that there will be any reasonable return on the capital invested in acquisition and improvement of the waterways. They also thought that though the improved canals might tend to lower rates where they compete with railways, this fact would tend to prevent reductions elsewhere. Nor did they support the recommendation that further restrictions should be placed upon railway companies to protect State-owned waterways, or the suggestion that the cost of acquisition of waterways as distinct from their improvement should be borne by the State, either without any pecuniary

return or on other and less onerous terms than apply to outlay on improvements.

Ten years have passed since this valuable report was issued, but there has been no outcome from it. It is true that during five of these years we have been at war, but it must not be forgotten that five years elapsed between the conclusion of the inquiry and the outbreak of the war, during which time steps might have been taken to give effect to the recommendations, or some of them at least; but, as far as I am aware, nothing was done. To an ordinary person it does seem extraordinary that the three years' labour and expense of a strong Royal Commission should be thus thrown away.

I desire also to refer to the second report of the Select Committee on Transport published on November 14th, 1918. The reference to canals is very brief, and concludes as follows: "There can be no question that the arrangements which have been made for the working of the canals during the war have been of great public value and have relieved the railways of a considerable volume of heavy traffic with which they found it difficult to cope. Your Committee, in the absence of further evidence which it desired to take, has not been able to come to any conclusion in regard to the most advantageous organisation for dealing with the canals, except that further amalgamation would be advantageous."

Finally, I wish to refer to two lectures given by Mr. R. B. Dunwoody at the Institution of Civil Engineers on the 16th and 30th of last month. These were the Vernon Harcourt lectures, his subject being "The Economic Requirements for Inland Navigation Transport in the British Isles." Mr. Dunwoody was Secretary of the Royal Commission and of the Canal Control Committee, and has, therefore, an intimate knowledge of the canal systems of the country. His two lectures contain a most able *résumé* of the whole subject of inland navigation in this country.

What, then, is the position of the canals of England at the present day? I may safely say that, to all intents and purposes, they are in the same condition as they were when constructed in the eighteenth century. It is true that the Aire and Calder Canal did lengthen its locks so that they can now pass a train of twenty-five compartment boats. They have also improved and developed the Port of Goole, so that coal can be loaded into ships more cheaply than at any other port. It is also true that in 1900 the Grand Junction Canal Company spent nearly £50,000 in building a wide boat inclined lift to replace a flight of ten narrow locks on the Leicester branch of their system, but if they did, they failed to reap the benefit of this improvement by doing the same to the flight of seven locks on the same branch at Watford, so that this wide boat channel can still only pass narrow boats. What has been the result? The traffic never developed as it was anticipated it would do, and, in November, 1910, the Foxton lift was closed, and is now practically derelict. But worse still, in 1902 the Company found that the Watford narrow locks needed rebuilding, and this was done in good blue brick, but they were again built only 7 ft. 6 in. wide, so that this bottle neck still remains. Of course, all the canals have been maintained in more or less good order, and in some cases I believe the companies claim that there is now a greater depth of water than what they were designed for. This may be so, but still the fact remains that no general improvement has been carried out, and the canals are practically in the same condition as when constructed.

I must make one exception to this sweeping statement, namely, the Oxford Canal. This canal was built as a contour canal at a time when the tolls were levied on the length of channel traversed. It was, therefore, to the interest of the company that the distance between any two points should be as long as possible. I have been told that the boatmen used to be able to hear all twelve hours of the church clock strike in getting from one side of Banbury to the other.

Between 1829 and 1834 the Company decided to remodel the channel. The plan now on the screen shows in dotted line the original alignment of a portion of the canal, the solid line showing the new alignment.

The improvement was carried out between Longford and Wolfhampcote, the distance by canal being reduced from 37·6 miles to 24 miles, at a cost of £167,172. The particular cut-off at Rugby shown on the screen was 1,782 ft. long, replacing 3½ miles of the old line. It involved crossing a turnpike road and the River Swift by a three-arched aqueduct, the embankment being 25 ft. high.

The Royal Commission, in the statistical statements which accompanied the report, divided the canals into three groups, thus:—

	Miles.
Independent canals	2,565
Railway-owned canals . .	965
Railway-controlled canals .	218
Total	3,748

The railway-controlled canals comprise:—

(*a*) The Birmingham Canal System, controlled by the London & North Western Railway.

(*b*) The Sheffield & South Yorkshire Canals, controlled by the Great Central Railway.

Both these systems were taken over by the Canal Control Committee when it was instituted in 1917.

The above looks a very considerable length of waterway, but as it includes considerable lengths of navigable rivers, many short isolated lengths of canal and many miles which have been abandoned, the really serviceable total mileage is considerably less.

Thus, the total mileage given above may, for our present purpose, be rearranged as follows :—

	Miles.
1. Under Canal Control Committee	1,234
2. Managed by railways	965
3. River navigations	513
4. Small, isolated canals still working	154
5. Small navigations of no importance	539
6. Canals which have been abandoned	343
Total	3,748

From this it will be seen that over 880 miles have been abandoned, or are of no importance, leaving under 3,000 miles in efficient use.

In several appendices to this paper I have detailed the various channels which I have included in each of these groups, and in the cases of Nos. 1, 2, 3, and 4, have given statistics of the tonnage carried for the years 1888, 1898, 1905, 1913, 1918, and, in the case of the controlled canals, for 1919.

The map now on the screen shows the four routes known as "the Cross," which the Royal Commission proposed should be improved. It will be seen that the main idea was to provide through routes from the Midlands to the Humber, Mersey, Thames and Severn.

They gave much attention to the question of the capacity of the canals which were to constitute this "Cross." They evidently would have liked to recommend that they should be made capable of passing 300-ton boats, but on very detailed inquiry came to the conclusion that there would be insufficient water to maintain canals of that size, and eventually decided on 100 tons.

Much water has flowed down the locks since the Commission sat, and I am myself of opinion its recommendations for the construction of "the Cross" for 100-ton barges will never be carried out in their entirety, but that is no reason why a beginning should not be made, which, if it proved successful, could be extended later on.

The most important point is, whether Government is going to do anything towards forming a Waterways Board, as recommended by the Commission, so that the numerous small undertakings may be amalgamated and brought under a single administration.

I need not labour this point: the absurdity of short lengths of seven, nine, eleven and thirteen miles of canal, in a continuous through route, being under separate administrations, each with its own board of directors, secretary, or manager, and office establishment, is too well known to require further comment.

Then, although it may now not be practicable to carry out the ambitious scheme proposed by the Commission, I am convinced that there are certain minor improvements which might be carried out at no great expense, which would materially improve the efficiency of the waterways, both natural and artificial, and I should like to indicate a few of them.

Those which stand out prominently are the connection of the large industrial centres of Nottingham and Birmingham with the coast ports by a good waterway.

The map now on the screen shows, to a larger scale, the main through water routes of the country, those under the Canal Control Committee in solid lines, and those under railwway management in heavy dotted lines.

During the past summer, by the invitation of the chairman and directors of the Trent Navigation, I took a trip from Leicester to Newark by water. From Leicester to Nottingham, we were able to travel over the Leicester and Loughborough Navigations in the steam launch, but from Nottingham to Newark we were obliged to go in a small open motor boat, drawing 2 ft. to 2 ft. 3 in. of water, and even then we several times grounded on the bed of the river. Now there is not the slightest doubt that, for a comparatively small sum the River Trent can be made navigable for boats of a considerable size, say 500 tons, past Nottingham right up to the junction of the Loughborough and Erewash Canals. Think what it would be to see coastal steamers, possibly of special design, coming right up into the heart of this industrial area. At Sawley, where such an improvement would end, it would connect with the Erewash, Loughborough, and Trent and Mersey Canals, and the great railway system of the country, by all of which the produce brought in could be distributed by narrow boats or rail.

In this connection I ought to say that the Nottingham Corporation are under statutory obligation to improve the river between Nottingham and Newark, so as to pass boats of 100 to 120 tons. In 1916 the cost was estimated at £160,000, and the Development Commission recommended the Treasury that a grant of

£50,000 should be made, under certain conditions, out of the Development Fund. It was impossible to proceed with the work during the war, and the cost is now estimated at £300,000, but so far the Treasury has been unable to promise any financial assistance to the scheme, and it will be necessary for the Corporation to apply to Parliament for an extension of the time within which they are bound to complete the scheme. I venture to suggest that, for very little increased cost, the river might easily be made navigable for boats of 500 tons.

Again, consider the case of Birmingham. At present its only water communications with the coast are by narrow boats carrying 28 to 30 tons. The routes available are :—

(*a*) By the Worcester and Birmingham Canal.

(*b*) By the Dudley branch of the Birmingham Canal, the Stourbridge Canal, and the Stafford and Worcester Canal.

(*c*) By the Birmingham and Shropshire Union Canals to Ellesmere Port, distance about eighty-five miles.

(*d*) By several branches of the Birmingham Canal to the Trent and Mersey, and thence by that canal to Preston Brook on the Bridgewater Canal, distance about 100 miles.

The first route joins the Severn at Worcester, and is thirty miles in length. The second joins it at Stourport, and is much the same distance.

The construction of a big boat canal from Birmingham to the Mersey would, it must be admitted, be an extremely costly undertaking, and certainly may at present be considered beyond the range of practicable suggestions, but a connection with the Severn seems to me quite a different proposition.

Birmingham is only sixteen miles, as the crow flies, from Stourport on the Severn, up to which point boats with 100 to 150 tons can at present pass. Mr. Martin, in his paper at the conference already referred to, says, that with a comparatively small amount of dredging, boats of 300 to 500 tons could be passed to Stourport. The Commission contemplated widening the Worcester and Birmingham Canal to take 100-ton boats. This distance, as the crow flies, is twenty-three miles compared with sixteen to Stourport. It seems to me that it may well be a matter for investigation, whether it would not be better and more economical to cut a new canal, designed on modern up-to-date lines, possibly fitted with lifts, instead of locks, so as to conserve water, than to widen the existing canal, which in itself is a difficult matter, while still keeping traffic going. However, this is not a point which need be discussed at the present moment. The point of importance is, that boats of considerable size should be able to pass from the coast to a large basin at some suitable site outside Birmingham. This basin would be at the Birmingham Canal level of 453·0, so that produce might be loaded straight to, or from, the narrow boats of that large system. Surely, it would be worth spending a considerable sum on such a project, and considering the prosperity that has come to Manchester from its investment in the Ship Canal, I am somewhat surprised that so prosperous and enlightened a Corporation as Birmingham has not seen the direct and indirect benefits of assisting to finance such a project.

In advocating such a scheme I do not think that I should be right to ignore the fact that Mr. Samuel Lloyd, in his paper on Improvements in Canal Communication at the conference in 1888, stated that the following was then the calculated percentage of goods from Birmingham and the district shipped at the various ports :—

	Per cent.
From Liverpool	43
,, London	40
,, Hull	10
,, Severn Ports	3
,, South Wales	3
,, Harwich, Grimsby, etc.	1

I am unable to say whether the same percentages hold now. If they do, it would be a question for Birmingham merchants and traders to say whether they would not be altered if good water communication existed to the Bristol Channel ports.

If I were a younger man there is nothing I would like better than to have the job of finding a route from Stourport to Birmingham, and working out the details of the project, but I do trust that it will be done by someone. But if it is to be done, the sooner it is started the better. Prices will never return to those before the war, and Birmingham may well think regretfully of what it would have cost to carry out the scheme before the war compared with what it must cost if ever carried out in the future.

Another scheme of great importance, but which would not cost a very large sum, is the construction of a new entrance to the Sharpness Docks at Sheperdine about six miles below the present entrance. The object of this is to obtain an additional depth of nine feet of water over the sill, so that steamers may not be detained in the river for a sufficient depth of water, so often, or so long, as is now the case. The sanction of the Ministry of Transport has recently been given to this scheme being worked out

in detail, and when this has been done it is to be hoped that money will be found to carry it out; it would unquestionably be of great benefit to the town of Gloucester.

It seems to me that these three schemes would be a good beginning of improvement in our water communications, and would be ample to commence with. Personally, I am doubtful of the necessity for connecting the Midlands with the Humber, Mersey, Thames and Severn by 100-ton boat canals, and it seems to me that advocates of canal development, by asking for too much, have ended, and are likely to end, in getting nothing.

At the same time, I think a limited sum might usefully and economically be spent in improving the existing waterways. Thus, it would be sound to enlarge the canal between Birmingham and Braunston, so that wide boats, or two narrow boats abreast, could pass through the locks. This would make a uniform gauge from London to Birmingham. At present a narrow boat fitted with an engine and propeller leaves London towing another narrow boat behind her. They can both pass into the wide locks of the Grand Junction Canal side by side, as far as Braunston. From there to Birmingham the canals are narrow, and the carrier finds it better to send the self-propelled boat on alone and to provide a horse to tow the other, instead of detaining the former while the two boats are passed separately through each of the locks. This improvement would not be a very costly matter.

Whether it would be worth while widening the Watford locks on the Leicester branch and reopening the Foxton lift, must depend upon the development of canal traffic. At present there is no indication that it would be a paying proposition. There are other minor improvements that might, with advantage, be carried out, but it seems to me quite useless to take up your time detailing them until Government has decided what its policy is going to be in regard to the canals as a whole. On this subject the evidence of Sir Maurice Fitzmaurice before the Select Committee on Transport is worthy of careful attention.

There is one question which is very seriously affecting the canal carrying trade at the present moment, and that is the attitude of the labour unions.

The introduction of the forty-eight hour week and the refusal of boatmen to work at night has affected the canals and carriers possibly more than any other industry. The manager of the Aire and Calder Canal recently told me that before the war a train of empty boats would travel by night from Goole to the colliery, load next day and return to Goole the following night; unload next day and again return to the colliery at night. Now the men will only work by day, with the result that it takes three days—72 hours—to do the trip, instead of a day and two nights—36 hours.

But the industry is likely to be affected in other ways. One of the clauses in the recent Peace Treaty provides that children under the age of fourteen shall not be employed in any industry. The labour union leaders have also recently approached Government with a view to prohibiting living on boat, at all, either by men, women or children. They urge that the accommodation is too small, insanitary and unhygienic; they admit that the families are content, and will resent being compelled to abandon living on their boats, but state that it is necessary for their social betterment. They also say that a very high percentage of children are drowned, and that they cannot be properly educated. As regards the first of these points, I can only say that my own observation is that I have seen no healthier families anywhere than those on the canals, and this is borne out by the pictures exhibited on the screen. Personally, I do not think there can be any comparison between the healthiness of canal boat family life and that of a family brought up in a city, I will not say a slum, because we all hope these will be done away with in time. The excessive loss by drowning is denied by the people most concerned, namely, the boatmen themselves. The question of education is, of course, a difficult one. The present system is that children on canal boats are given a travelling ticket permitting them to attend school at any place where the boat is tied up. No one can pretend that this is a satisfactory arrangement, and the education obtained must indeed be elementary. I believe it is a fact that the standard of education amongst canal boat workers is low, but in my opinion education is not everything in this life, and a lower standard of education with better physical fitness may in the end give the most useful citizen.

I have not made exhaustive inquiries as to what proportion of boatmen live on their boats with their families. I understand that on the Shropshire Union Canal, 90 per cent. of the boats are in charge of a man and his wife, and nearly all have young children on board.

The director of the Anderton Company, who own and work eighty-three boats, informed me that of their boatmen, one-third own houses and live in them when not actually working on the boats; one-third own houses, very seldom occupy

them, but use them mainly as headquarters to store their belongings; one-third live entirely on the boats.

I am unable to say, without further inquiry, whether these proportions would apply generally to other carriers. Some years ago a census of the canal and river population was taken, with the result it was found that of 60,000 employees, 10,000 men, 4,000 women, and 2,000 children lived on the boats.

There can be no doubt that children are of the very greatest service on a canal boat. It is no uncommon thing for a man and his wife, with the aid of their children, to work two boats. The man takes charge of one and his wife of the other, the children guiding the horse, who probably knows them well, and is obedient to their orders. One case has been reported to me where a man and his wife, with nine children, regularly work three boats. The four eldest of the children are respectively eighteen, seventeen, sixteen and thirteen years of age, the one of sixteen being a boy and the other three girls. The whole family lives on the three boats. If children are to be allowed on boats at all, it is difficult to see how parents can be prevented from using them in work suitable to their strength and ability; anyone travelling over the English canals cannot but be struck by the appearance of the children, fine and healthy with rosy cheeks. They are, in my experience, well fed and clean. I am infomed that to prevent young children under the age of fourteen being initiated into the intricacies of canal transport would be disastrous. If young boys and girls are not allowed to assist their parents, there is every likelihood that, when they attain the age of fourteen, they will not take up work on the canals at all, but will find work in the towns.

The rules at present governing the residence of children in canal boats are those contained in Part III. of Local Government Regulation No. 7,768 of March 20th, 1878. I need not recapitulate its provisions here, but it will be seen that they consist entirely of rules fixing the number, age and sex of persons who may be allowed to dwell in a canal boat having regard to the cubic space, ventilation, separation of the sexes, healthiness, and convenience of accommodation of the boat—subject to these rules, there is no limit to the number or ages of the children that may reside in a boat.

In conclusion, I may say that it is certain that any order prohibiting living on boats would apply to a very large number of people, and would very seriously affect the canal carrying trade. Indeed, it is difficult to see how long-distance traffic could be continued at all, if boatmen are not to live on their boats. It would be practically impossible to provide rest houses for them to stop in at night, for a man cannot always be certain where he will get to, nor would it be safe to leave valuable cargoes unprotected at night by the side of a canal. There is, of course, no certainty that action will be taken in the matter by the Government, but the application of the union leaders shows what is moving in their minds, and may very greatly determine the future of canal transport.

In this connection, too, I may state that one of the items in the national programme of the National Federation of Transport Workers, which has recently been put forward and is now under consideration of the Ministry of Labour, is that two adult males should be in charge of every boat. As, at the same time, they also demand a wage of £4 10*s.* per week for the captain, and £4 5*s.* for the second man, for an eight-hour day, with overtime at time and a half or double time for any hours in excess of eight per day, it will be seen that the expense of carriage by canal may render that means of transport prohibitive.

I regret that my paper should not depict the canals of the country and the prospects of canal carriage in a more favourable light; but there is no gainsaying the fact that at the present moment most, if not all the canal companies are bankrupt, and that unless something is done to revivify them they must eventually close down, which, I venture to believe, is unthinkable.

That the above statement is no exaggeration is shown by the fact that there were only eight of the controlled canals whose receipts in 1918 exceeded their working expenses, while on the whole of the controlled canals the deficit amounted to £240,774. This without the payment of debenture or any other interest to shareholders. As expenses in 1919 have still further increased, the deficit in that year will be much greater, as indicated by the increase in the Government contribution. I have not considered it necessary in this paper to refer to the question of the increase in railway freight rates and their effect on the canals. The matter has been carefully studied by a Committee, of which I am a member, at the Ministry of Transport. I may, however, say that increases in the canal tolls and freights, similar to those introduced on the railways from January 15th, would not be sufficient to put the canals, as at present administered, in a sound financial position.

APPENDIX A.

SHOWING MILEAGE AND TRAFFIC CARRIED BY INDEPENDENT CANALS CONTROLLED BY THE CANALS CONTROL COMMITTEE.

Name of System.	Length in Miles.		1888.	1898.	1905.	1913.	1918.	1919.	Compensation Paid by Canal Control Committee.		
	Wide.	Narrow.							1917.	1918.	1919.
			Tons.	Tons.	Tons.	Tons.	Tons.	Tons	£	£	£
Aire and Calder including	85·25	—	2,210,692	2,412,062	2,810,988	3,597,921	1,594,441	1,563,763	102,030	158,672	142,724
Bradford Branch	—	—	80,674	96,037	98,271	—	—	—	686	1,878	—
Birmingham	—	159·00	7,713,047	8,627,074	7,546,453	7,090,628	6,091,735	5,557,672	38,314	80,623	129,317
Bridgewater	87·75	—	2,769,513	2,277,748	2,170,381	2,171,311	1,355,961	1,354,019	80,631	147,857	259,137
Calder and Hebble	27·50	—	579,766	446,908	463,285	482,983	286,215	278,948	6,934	10,425	11,688
Coventry	—	32·25	451,521	366,842	425,774	537,870	465,921	432,952	492	2,279	—
Erewash	11·75	—	111,006	94,294	80,067	70,568	105,722	46,654	47	—	1,321
Glamorganshire	—	9·25	557,559	205,530	249,760	374,298	242,693	234,422	—	4,391	5,101
Worcester and Birmingham	8·50	30·00	392,605	437,992	392,028	363,924	240,426	240,665	26,727	43,779	31,936
Gloucester and Berkeley	16·75	—	No return	747,013	1,053,721	993,400	488,964	670,364			
Grand Junction	117·75	65·00	1,252,563	1,620,552	1,794,233	1,668,149	1,116,717	1,218,602	23,765	44,763	71,535
Leeds and Liverpool	145·50	—	2,016,976	2,324,968	2,467,827	2,308,210	1,899,701	1,872,981	50,846	102,489	132,419
Leicester	15·75	—	95,843	94,038	82,551	109,928	57,552	65,322	201	688	—
Loughborough	9·25	—	79,630	73,304	61,408	84,391	39,684	44,125	623	997	776
Oxford	—	81·75	450,000	421,507	378,698	453,609	321,519	286,459	5,821	9,792	14,815
Regent's	10·75	—	1,672,959	1,041,506	1,045,184	1,531,606	859,428	1,078,729	18,000	31,024	27,185
Rochdale	34·50	—	686,119	624,433	554,597	512,061	354,266	323,952	13,293	30,356	39,969
Severn Navigation	45·00	—	323,329	292,326	75,198	297,882	137,645	156,073	3,480	5,761	6,952
Sheffield and South Yorkshire	59·00	—	927,254	982,730	835,982	920,876	318,554	283,879	15,909	30,734	44,953
Staffordshire and Worcestershire	—	51·75	646,038	767,577	722,640	722,876	487,123	496,769	4,714	8,027	11,415
Stourbridge	—	7·25	121,128	326,494	334,933	375,059	268,122	271,280	—	385	1,628
Stroudwater	8·00	—	67,940	49,455	42,809	37,291	31,480	27,319	—	—	283
Trent Navigation	68·50	—	199,525	418,027	349,511	388,851	348,974	281,343	—	5,316	16,261
Birmingham and Warwick Junction	—	2·50	194,680	204,116	288,978	269,072	545,945	464,900	Surplus	Surplus	Surplus
Warwick and Birmingham	—	22·50	353,118	354,022	325,391	375,609	353,340	297,574	1,171	2,196	11,533
Warwick and Napton	—	11·25	236,353	196,842	179,873	220,183	167,998	126,692	953	1,715	2,773
Weaver	20·00	—	1,498,124	1,223,246	1,076,572	1,138,643	668,348	698,116	15,663	23,891	29,392
Total	761·50	472·50	25,687,962	26,726,603	25,907,113	27,087,199	18,848,474	18,373,556	410,300	748,038	994,494
	1234·00										

APPENDIX B.

SHOWING MILEAGE AND TRAFFIC CARRIED BY RAILWAY-OWNED CANALS.

Name of System.	Length in Miles. Wide.	Length in Miles. Narrow.	1888.	1898.	1905.	1913.	1918.	1919.
			Tons	Tons.	Tons.	Tons.	Tons.	
Ulverstone	1·50	—	3,052	4,623	3,472	5,715	No return	Not available.
Great Central Railway	—	58·50	557,023	471,040	349,742	284,354	192,598	
Chesterfield . . .	—	45·25	—	62,075	45,177	56,671	38,633	
Grantham	33·00	—	27,376	34,291	18,802	11,511	4,556	
Nottingham . . .	15·00	—	109,064	150,472	123,408	144,979	88,529	
Witham River . . .	31·50	—	20,567	20,958	18,548	6,971	7,444	
Fossdyke	10·75	—	26,066	58,133	75,881	85,797	64,825	
Bridgewater and Taunton	15·25	—	17,699	13,148	6,420	—	—	
Grand Western . .	10·75	—	4,113	1,952	5,182	6,625	1,950	
Kennet and Avon . .	86·50	—	135,802	112,716	63,979	53,713	23,158	
Monmouthshire . .	—	19·75	39,157	20,826	25,158	23,346	8,612	
Stourbridge Extension	—	3·00	129,656	163,534	167,402	125,834	110,204	
Stratford-on-Avon . .	—	25·75	48,818	45,126	34,323	36,078	16,099	
Swansea	—	16·50	385,707	192,382	123,269	99,177	49,726	
Manchester, Bolton, and Bury	16·00	—	620,345	695,410	654,149	466,991	320,769	
Huddersfield . . .	23·75	—	179,570	161,899	97,939	91,753	62,438	
Lancaster	59·75	—	173,882	173,242	140,453	120,615	47,591	
St. Helens	16·50	—	503,978	381,863	292,985	211,167	155,867	
Coalport	2·00	—	50,293	56,375	29,066	not fully open for traffic.		
Shropshire Union . .	28·00	173·75	1,124,598	1,111,602	605,161	1,533,220	812,383	
Ashby	—	30·25	72,704	35,627	34,663	30,020	7,723	
Cromford	—	17·25	45,226	52,243	39,889	36,863	45,540	
Lydney	·75	—	—	—	22,909	—	—	
Ure River	10·25	—	6,077	9,001	3,409	9,437	1,766	
Pocklington . . .	9·25	—	1,001	2,073	1,076	1,657	55	
Derwent	38·50	—	11,799	8,583	6,076	4,286	965	
Trent and Mersey . .	—	119·50	1,139,098	1,215,540	1,137,663	1,051,930	689,945	
River Avon	11·00	—	Included in Kennet and Avon Canal.					
Brecon and Abergavenny Canal . . .	—	33·75	Included in Monmouthshire Canal.					
Stover Canal . . .	1·75	—	Leased by Railway to Messrs. Watts, Blake, Bearn & Co.					
Total . .	421·75	543·25	5,432,671	5,254,734	4,126,201	4,498,710	2,751,376	
	965							

APPENDIX C.

Statement showing Mileage and Traffic carried on River Waterways.

River.	Mileage.	1888.	1898.	1905.
		Tons.	Tons.	Tons.
Avon (Bristol)	14·25	No figures.		368,088
,, (Warwick)	28·25	4,785	9,826	9,609
Chelmer and Blackwater	13·75	18,335	13,869	15,725
Driffield Navigation	10·50	28,818	24,117	32,666
Dee	23·00	No figures available.		
Dartford and Crayford	3·50		ditto.	244,848
Humber	40·00		ditto.	
Hull	20·25		ditto.	
Lee	33·75	517,740	614,746	65,695
Linton Lock	9·25	—	23,521	17,275
Medway	22·25	393,191	521,947	
Mersey	18·50	No figures available.		
Ouse and Foss	41·50	—	262,901	390,400
Stour (Suffolk)	23·50	22,354	20,092	15,163
Thames	144·00	728,966	1,266,943	1,395,642
Tees	25·00	No figures available.		
Tyne	19·25		ditto.	
Wey	14·75	25,983	33,516	30,601
Wey (Godalming)	5·75	2,805	2,918	1,492
Total	511·00	1,742,977	2,794,396	2,585,204

APPENDIX D.

Statement showing Mileage and Traffic carried on Small Isolated Canals.

Name of Canal.	Mileage.	1888.	1898.	1905.
		Tons.	Tons.	Tons.
Ancholme	19·00	14,765	50,699	53,147
Clifton and Kearsley	1·50	—	—	142,905
Derby	18·50	85,484	82,200	No return.
Exeter	5·75	30,514	50,442	38,339
Ipswich and Stowmarket	6·00	39,437	38,300	31,500
Leven	3·25	4,242	3,194	4,546
Middle Level	83·25	44,034	42,640	12,770
Neath	13·00	37,754	13,180	No return.
Surrey	3·75	42,809	510,500	596,545
Total	154·00	299,039	791,155	879,752

APPENDIX E.

Showing Small Navigations of no Importance Included in the Statistical Table of the Royal Commission's Report.

Name of Navigation.	Miles.	Name of Navigation.	Miles.
Adur River	6·00	North Walsham Canal	7·50
Aire River	12·00	Lower Ouse Navigation	6·50
Arun River	15·75	Lark Gate	0·50
Aysham Navigation	12·00	Pensett Canal	1·25
Black Sluice	20·75	Roding River	1·75
Brandon River	14·00	South Level Navigation	63·75
Bure River	54·00	Stort River	13·50
Burwell Lock	3·25	Stour River	19·50
Cam River	6·50	Duke of Sutherland Canal	4·25
Chet River	3·50	Swoffam and Botisham Canal	8·25
Chichester Canal	4·25	Somerset Coal Canal	9·50
Colne River	11·25	Tamar River	3·50
Don River	9·25	Tennant Canal	8·50
Framley Cut	0·25	Dr. Thomas' Canal	1·00
Foss River	1·75	Thorney River	3·00
Foxley Branch Canal	0·75	Teign River	5·50
Glen River	1·25	Waveney River	25·75
Grosvenor Canal	0·25	Welland River	23·75
Hackney Canal	0·50	Wisbech River	5·25
Houghton Branch Canal	0·25	Witham River	39·25
Kyme Eau	6·50	Wandsworth Cut	0·50
Lakenheath Lode	3·25	Wharfe River	9·25
Louth Navigation	11·75	Wye River	15·00
Larke River	16·25	Yare River	35·00
Earl of Manver's Canal	——	Yeo River	8·25
Neath River	4·00		
	219·25		319·75

Total . . . . 539 miles

APPENDIX F.

Showing Navigations which have been Abandoned.

Name of Navigation.	Miles.	Name of Navigation.	Miles.
Glamorganshire Canal	23·25	Market Weighton	6·00
Aberdare Canal	6·75	Nene Navigation	78·75
Bude Harbour Canal	2·00	Ouse Navigation (Huntingdonshire and Bedfordshire)	83·50
Ipswich and Stowmarket . . .	9·75	Nutbrook Canal	4·50
Parrett River	35·75	Thames and Severn Canal . . .	30·00
Tone River	6·50	Wiltshire and Berkshire Canal . .	69·00
Basingstoke Canal	37·50		
	121·50		221·75
Total	343·25 miles.		

DISCUSSION.

The Chairman (Mr. Neville Chamberlain, M.P.), in opening the discussion, said the paper was very interesting, informing, and carefully prepared. He was much gratified at being invited to preside at the meeting, because for a good many years he had made it a practice to seize any opportunity that presented itself to talk about canals to anyone who would listen to him. Although the intervention of the war made it necessary to shut down the activities of the Waterways Association, of which he had the honour to be Chairman, yet he might say that at the beginning of the war the Association had made some substantial progress in educating not only public opinion but also Departmental opinion upon the advisability of taking the subject of canals a little more seriously than had been done before. With regard to the present situation of canals and inland waterways, the author had concluded his paper with a picture of the present financial position of canal companies which was melancholy, but, he was afraid, not in the least exaggerated. That was not the fault of the companies, but was due to the circumstances of the war. The Government, by artificially keeping down the railway rates, had made it impossible for canals, which were not subsidised to the same extent, to compete with the railways, and consequently traffic had been driven off the water and on to the rails. For the most part nothing whatever had been done to the canals since they were constructed to improve them and to enable them to take advantage of modern advances in engineering science, and they had to compete with railways on which some of the finest brains in the country had been perpetually at work until they had been brought to a high pitch of efficiency. Therefore it was absolutely impossible to suppose that for many years to come canals could be on an equal footing with railways. This country had got to make up its mind whether it was going finally to abandon the prospect of inland water carriage altogether, or, if it was not prepared to take that view, then it must be willing to foot the bill and to treat the matter, not as a commercial proposition, but as a preparation for an improved state of affairs, when canals would be brought up to a condition comparable with that of railways and would be able to do for this country something that might fairly be compared with what canals on the Continent were doing for Continental countries. The author said in his paper that he did not think it was of much use to go into details of minor improvements until the Government had declared what its policy was going to be with regard to canals as a whole. That particularly affected him, because two days ago in the House of Commons an announcement was made by the Parliamentary Secretary to the Ministry of Transport that the Minister intended to set up a Committee to inquire into the possibility of minor improvements to canals, and that he hoped to have his (Mr. Chamberlain's) assistance as Chairman of that Committee. He regretted somewhat that that statement was made, because it was entirely premature. The fact was that he took precisely the same view of the question as the author took. In his opinion it was necessary first of all to have a definite policy decided upon, and only then would it be worth while to consider what minor improvements could be carried out in canals. Under the Transport Act powers were given to the Minister of Transport to take possession of the canals for a period of two years, and those words "take possession" had a technical meaning in the Act. They did not mean necessarily to buy up the canals, but they meant to take control of them. If the Minister of

Transport took possession of the canals he had power to do a good many things. He could close such parts as were at present useless; he could give grants and make small improvements; he could have the canals dredged, many of them having got very badly silted up during the war; he could enlarge locks; and he could set up a Committee to control the whole of the canals, railway-owned as well as independent, and that Committee, by co-operation with the Railway Executive Committee, could see that rates were so arranged as to divert to the canals the heavy and bulky traffic which they were particularly well fitted to carry and which at present was congesting the railways. During those two years the Minister of Transport could do what it was laid down in the Act he was to do, *i.e.* he could consider and formulate a permanent policy with regard to the inland waterways of the country. If he did what he had the power under the Act to do, *i.e.* if he took possession of the canals, he would come up at once against the very difficult problem of what was to be the ultimate ownership of the canals. The author had pointed out that at the present time canals were owned by a multiplicity of authorities; short lengths of comparatively few miles, forming parts of a through route, were under the direction of different Boards. If during the period of two years the Minister were to carry out improvements upon any of those short lengths, the question would arise at the end of that time, supposing he intended to hand that canal back to its original owners, what was to be done about the improvement—who was to pay for it, who was to have the benefit of it? The railway companies, too, would have something to say if the railway-owned canals were taken from them for the period of two years and were then to be returned to them. Therefore he thought it was absolutely necessary that the Ministry of Transport should make up its mind quickly as to what was to be the ultimate ownership of the waterways. He did not hesitate to say that in his opinion it had got to be public ownership. He liked to see private enterprise developed to its utmost extent, and developed as much as possible in the direction of carrying upon the canals, but he considered that the economic return upon money expended in the maintenance and improvement of the waterways themselves was so doubtful that, seeing it was in the interest of the whole community that the waterways should be maintained, the cost should be borne by the community and could not be expected to be borne by any private enterprise. Just as the roads of the country were maintained by the community and put at the disposal of anyone who chose to run a vehicle upon them, so he thought the canals also ought to be kept and maintained at the public expense, but of course always subject to the payment of tolls. If that policy were adopted and declared, people would know where they were and what they were working towards. The two years given to the Minister would not be any too long for having the whole subject investigated as to what large major improvements should be carried out, such as some of those mentioned by the author, where through routes, and especially river routes, offered a prospect of considerable benefit to the industries of the country. There would be questions connected with those large improvements which had never yet been thoroughly thrashed out. How were they to be financed? How were the contributions to be made by the State or by the great local authorities, which stood particularly to benefit by the improvements, to be assessed? What was going to be done, for instance, with the landowner who had a frontage upon the present route, a frontage which would be immensely improved in value if the widening of the canals took place to the 100-ton standard? Was he to have the whole benefit of that, or was some portion of it to come to those who were finding the money for the improvements? He believed those problems could be solved, but they had never yet been given to anybody to solve. He would like to see a Committee set up to consider what would be the best policy to follow in respect to those large improvements, and, by the time they had investigated the whole subject and made their report to the Minister, it was at any rate conceivable that the financial position of the country would have so improved as to make it possible to put before Parliament a scheme which would certainly require the expenditure of a considerable sum of money—an expenditure which at the present moment would have very little chance of acceptance by the Government or by the House of Commons. Briefly, he believed the first action of the Minister of Transport should be to take possession of the canals; that he should announce his policy at the earliest possible moment, first as to whether the canals were to remain an integral part of the transport system of this country, and, secondly, as to what was to be their ownership; that he should set up a Committee to operate and control the canals of which he took possession, to recommend to him the points on which a comparatively small expenditure would produce the best result; and that he should have an Advisory Committee set up to investigate and to report to him in due course upon the policy to be adopted as to major improvements. If those suggestions were carried out, he thought the problem would have some substantial prospect of solution in the near future.

Sir John Eaglesome, K.C.M.G. (Aire and Calder Navigation), said the author had written a very interesting paper on a subject that was usually regarded as an uninteresting one, but he had forgotten to mention the part he himself played in connection with canals during the

war, first of all as Chairman of the Southern Sub-Committee and then in organising and successfully working a system for training men belonging to the Transport Workers' Battalion, which was afterwards introduced all over the country. Later on the author succeeded Sir Maurice Fitzmaurice as Chairman of the Canal Control Committee, which might be regarded as a model to some other Government Controls. Personally he thought the chief thing the matter with canals was that they were not sufficiently understood. People went along in a train and saw a barge with a horse pulling it, and that reminded them perhaps of a shady walk somwehere, or, as he heard the Chairman once say, of a rustic angling club. If people ever went so far as to talk about canals they said: "I suppose canals are out of date," or, "Why do not you make more use of your canals, as they do on the Continent?" It was no good making that sort of comparison —one might as well compare an English river with the Mississippi, which had 14,000 miles of navigable waterway. The Rhine carried 40 per cent. of the whole of the water-borne traffic of Germany, the four chief rivers in Germany carried 80 per cent. of the whole, and the Seine carried 26 per cent. of French water-borne traffic; but this country was an island with a backbone running down the centre that took a lot of climbing, although where the country was flat, as it was in some parts, water transport was very suitable. Another point to be remembered was that there was not a single manufacturing town in this country more than seventy miles distant from a sea port. That fact gave rise to two schools of thought. One said: "The sea is very close and there are plenty of railways—what more do you want?" The other said: "The sea is close; why do not you develop along the natural lines of drainage and bring it closer still?" That was done once, in the case of the Manchester Ship Canal; the shareholders made nothing out of it, but Manchester improved and developed greatly in consequence. That happened in a good many other cases where people who did not usually patronise canals made use of them for keeping railway rates down. There were two points that he would like to bring before the meeting with regard to English canals. The first was that where the country was suitable for a canal that canal would be successful; but many of the canals in this country were built when they had to compete with pack animals or a primitive kind of wheel transport; then the era of steam began, and workshops and factories were built which all wanted water, and therefore they were built with their walls right on the canal bank and were all dependent on the canals now for water even. Those places had a certain amount of advantage, because it was obviously better to take coal out of a barge right into the works than to take it out of a railway wagon in a yard, even if it only had to be wheeled fifty yards. Many of the canals in this country were like one in North Wales that he once travelled along in a comfortable barge with no traffic to interrupt the view; the other kind of canal could be seen at Birmingham, Manchester or Liverpool, where all the heavy work was done, and that was the kind of canal that the average man did not see. The second point he wished to mention was the question of improvement. The canals were built with different draughts, different sizes of locks, and different gauges, by men of genius who had a great many difficulties to contend with; they had not large funds, and they had difficulty in the kind of country through which the canals travelled. Therefore the question now had to be considered of improving them. Any improvements would greatly benefit the country, but if the Minister of Transport said, as he once did, that every transport undertaking had got to stand on its own legs, he would find it difficult to obtain a direct return from the capital expenditure involved in the improvements. If ever a town deserved a good canal, that town was Birmingham. Seven million tons of traffic were carried on the Birmingham Canal every year before the war, and he was told that the goods traffic per ton mile on the Birmingham Canal was actually heavier than the goods traffic per ton mile on the London and North Western Railway. With regard to a canal being suitable if it was in the right kind of country, that applied particularly to the canal that he knew most about, the Aire and Calder, which was quite different from the derelict and old-fashioned canals that people were apt to think of. It started at the junction of the Trent and the Ouse, and 2,000-ton boats could go up it to Goole, where there was accommodation for about eighty ships. From Goole there was a canal 70 ft. to 90 ft. wide, navigable by boats of 7½ ft. draught, which allowed the large barges which navigated the rough water of the Humber to go through the port of Goole and right up to Leeds and Wakefield. The canal had got the system of compartments which the author had described, like a railway train, with couplings and buffers and pulled by a tug, like an engine. Mr. Dunwoody had produced figures showing that in France and Germany before the war more than one-third of the water-borne traffic was coal and more than one-quarter was building material. That was the sort of traffic that canals ought to have, and this country might well follow the example of the Continent in that respect. The ideal arrangement was to have a canal on one side of a works and a railway siding on the other, and to bring up the heavy material, such as coal and ore, by water, and the material that required to be brought quickly by rail, and to send away the finished products by rail. Unfortunately that ideal combination

had very often in the past resulted in a senseless rate-cutting competition, with the evil result occasionally of cutting down the wages of the lower-paid operating staff. The dock and navigation trusts that had done such great service to the nation in the past were now, as the author pointed out, not in a position to pay their way, except by raising the tolls and by increasing traffic facilities. But increased traffic facilities meant increased capital expenditure, and most of the companies were not in a position to borrow. No one was going to lend money at 2½ or 3 per cent. when he could get gilt-edged securities at 6 per cent. It would be little short of a national disaster if those trusts were compelled to curtail their services, to reduce their maintenance, and to suspend all developments for want of a little support during the period of stress through which they were now passing.

Mr. R. F. de Salis (Grand Junction Canal) congratulated the author on the very interesting paper he had read. There was one criticism he would like to make on the author's remarks concerning his own Company, as he was rather severe on the Foxton lift and Watford locks. The fact was that the Company bought the Leicester canals primarily for their valuable water supplies, and then, as a second string, tried, by dredging, to put them into a fit state to carry traffic. The Company were induced, by the hope of increasing traffic from the Midlands, especially coal traffic, to build the Foxton lift, which would carry two narrow boats or one wide boat or barge, but they found the traffic did not come. In fact, one canal, the Nutbrook Canal, which should have been one of the principal feeders, had been allowed to become derelict, and they also found that the canal tunnel connecting the Erewash and the Cromford Canal was allowed by its owners to become impassable. They therefore felt they could not ask their shareholders to put up a lift at Watford, as was originally proposed, and as they found that practically all the traffic was carried in narrow boats they felt that to widen the Watford locks would have been waste of money until they saw their way to obtain more traffic, of which he was sorry to say, there was no prospect at present. The author had spoken of the necessity for amalgamation of canals. That was so obvious that the natural criticism must be: "Why on earth have not these canals amalgamated before?" But the canals in the south found themselves faced with the question of parochial rates. At present they were rated as agricultural land, but directly they went to Parliament for an Act, which was necessary for amalgamation, the parochial authorities wanted to put them on the basis of railways and rate them on their trade. His own canal did make an arrangement to amalgamate with the Warwick Canals some years ago, and that would obviously have been a great improvement and would have caused the enlargement of the locks on the Warwick Canals, which were narrow, while those on the Grand Junction Canal were wide. That scheme had the warm support of the late Mr. Joseph Chamberlain, but he was unable to overcome the rating difficulties. If they had gone on with the Bill and changed their form of rating they would have lost more than they would have gained by the amalgamation. That was another argument for some form of Government or central control. With regard to the general question of canals, the view put forward by the author and the Chairman was, he thought, the view of all those who were expert in canal management. With the present heavy demands of labour, both in money and in concessions, it was utterly impossible for either the canals or the traders on the canals to carry on in competition with other forms of transport. If the rates were raised to anything like the railway level, that would be a mere drop in the bucket; it would not enable the canals or the traders to live, and the natural consequence was that if the canals were not subsidised in some form or other they would to a considerable extent become derelict. There were certain sections of the canals which would pay and would be kept going as commercial concerns, but the Government had now to decide whether they were going to look on canals from the commercial point of view, and if a canal or a section of a canal did not pay, to let it become derelict, or whether they were going to look on the subject of canals as a national question and, either by taking them over or in some other way, keep them going with possibilities of improvement where money could be usefully spent.

Sir James Bruton, M.P., wished to congratulate the author on his singularly capable address, and to thank him for the very clear and interesting slides that he had shown. He drew the attention of those present to the fact that in 1913 there was traffic to the extent of 32½ million tons carried on the inland waterways of this country, representing some 4,500,000 truck-loads. If the recommendation of the Canal Commission alluded to by the author had been carried out during the war, an enormous advantage would have accrued to the country and a great saving of railway traffic would have been brought about. If the same support and encouragement had been given to canals as to railways, it would undoubtedly have had a good effect. No encouragement, however, was given to canals; in fact, it was not until 1917 that any attempt was made to protect their men. By that time a large number of them had gone, and it must be borne in mind also that boats were not being built and there was the greatest difficulty in getting boats repaired. Altogether the traffic on the inland waterways had decreased

during the war by 33 per cent. Those interested in canals looked to the Chairman as their leader in the House of Commons to press forward the question of waterways, and they were sure that if the Minister of Transport appointed a Committee, as suggested, it would be a step in the right direction.

Colonel J. A. Saner (River Weaver Navigation) said that, like the other speakers, he desired to congratulate the author on the way in which he had brought the subject of canals before the meeting. It was not at the present time a very happy thing to be connected with canals and waterways. He had personally taken part in the Conference convened by the Society of Arts in 1888, and he was sorry that more progress had not been made up to the present, but there were many difficulties in the way. One was the fact that the canals were now very much as they were a hundred years ago—they had not been brought up to date. People did not take into consideration (or at any rate they had not up to the time of the war, when they suddenly became aware of the fact that it was necessary to be economical with coal and with other forms of energy) that carriage by water was more economical in regard to coal and petrol and other forms of energy than carriage by rail. That was one of the most important points that ought to be taken into consideration by the Minister of Transport when he was deciding whether to resuscitate the canals and to take them over for the benefit of the nation as a whole. He had been Engineer to the River Weaver Navigation for about thirty years, and he had always wondered why it was that he could not persuade people to improve the waterways, especially the Weaver, further inland. The Trent and Mersey Canal was connected with the Weaver and also with the Mersey, and boats could come up the Weaver with anything up to 400 tons on board. They came up to Winsford, which was forty miles from Liverpool, and at Anderton there was a lift worked by electric power, which raised the small canal boats up into the Trent and Mersey Canal. At the present moment paraffin-driven boats went up the Anderton lift and to Middlewich, six miles beyond Anderton, and then they could go no further, because the locks were small seven feet wide locks up to Stoke, which could only take 25-ton boats. If those paraffin-driven boats, which could carry seventy tons of material at an expenditure of three-quarters of a gallon of paraffin per mile, could go up to the potteries at Stoke, a very great improvement would be effected and the result would be commercially successful. Up to the present there had been two owners of the waterway from the Mersey to the Potteries—the North Staffordshire Railway owned part of it and the Weaver Trustees the other part—and they had never come to any arrangement to work it mutually or to improve it. Those were the sort of things that would have to be considered when the policy with regard to canals had been determined. It was no good carrying such materials as coal and limestone and bricks by rail, taking them at the rate of forty or fifty miles an hour and then allowing them to lie in the contractor's yard for three or four weeks before they were wanted. If they were carried by water at five miles an hour they would get to their destination in time, without the expenditure of so much energy. He hoped the experience of the war would teach the people of this country to conserve the energy that they had in the country. He also hoped that under the new Ministry of Transport the canals would be worked more economically and more harmoniously, and that the difficulties which had arisen through the competition of the different Companies would be overcome.

Mr. G. R. Jebb, M.Inst.C.E., said no one could have appreciated the paper more than he had done. When he heard that a Committee was to be appointed "to consider what development of canals and waterways was practicable, having regard to the financial position of the country at the moment," he was afraid that the author and the Chairman might possibly recommend a resuscitation of the larger schemes referred to by the Royal Commission, which he had always opposed on economic grounds, and he had come prepared to state his arguments against such schemes, but after listening to the moderate and temperate suggestions made in the paper, and the remarks of the Chairman, he decided to say nothing about the larger schemes. It would, however, be necessary that any recommendations that might be made by the new Committee, and particularly any that might have reference to the making of a new canal from Birmingham in the direction of the Severn, should have very careful consideration, with the view of ascertaining whether they could be justified, having regard—among other things—to the financial position of the country.

Mr. R. B. Dunwoody (late Secretary, Canal Control Committee) said he was pleased to have had the opportunity of listening to the paper, which had brought out a number of new points. The Chairman had stated very clearly the exact position of the question at the present time. The Minister of Transport had to decide what was to be done; he could advise the Government to carry out the recommendations of the Royal Commission or some other scheme. If the report of the Commission was read carefully, it would be seen that it did not say that the "Cross" scheme should be carried out at once—what it recommended was that a Board should be set up which should have the power to go into the whole question afresh and make recommendations to the Government as to what should be done. Nothing could be done until

Parliament passed new legislation, and therefore to say that the Royal Commission recommended the Government to go ahead at once and carry out the scheme was not exactly stating the facts.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to the author for his interesting paper.

MR. PRESTON, in reply, desired to say, with reference to Sir John Eaglesome's remarks, that if he had had any success as Chairman of the Canal Control Committee it was entirely due to his predecessor, Sir Maurice Fitzmaurice, who laid the foundations of the canal control. He had only carried on, with the aid of Mr. Dunwoody until quite recently, what Sir Maurice had begun. In conclusion, he would like to repeat one remark which he made with reference to the present state of the canals when Mr. Dunwoody read his recent lecture on canals at the Institution of Civil Engineers. Could one imagine what would be the present state of motor traffic if the roads of England were in the same condition as they were before Macadam lived, and if they had been dependent for development and improvement on the turnpike tolls? Could motor traffic ever have developed under those circumstances? Even after Macadam had made his beautiful metal roads, directly the motor came they were inadequate and tarred roads had to be constructed. Yet the canals were in the same condition now as when they were built.

The meeting then terminated.

CORRESPONDENCE.

CAMOUFLAGE.

With reference to the paper on "The Dazzle Painting of Ships" I send you a note on various meanings of "Camouflet" or Camouflage."

"Camoufle" was an old French word meaning smoke.

"Dictionnaire Usuel de la langue Française," par A. Bourguignon, Paris, 1877, has the following: —

CAMOUFLET, s.m. Fumée épaisse qu'un souffle malicieusement au nez de quelqu'un avec un cornet de papier allumé. Fig. et Fam. Sanglant affront.

"Dictionnaire Historique d'Argot": Loredan Larchey, Paris, 1880, has the following: —

CAMOUFLER. Déguiser. (Beauvillier.)

And in the Supplement:—

CAMOUFFLÉ. Homme portant fausse barbe. (A. Pierre.) De Camoufler (se): se déguiser.

CAMOUFLER LA BIBINE. Falsifier (mot à mot: déguiser) la bière.

The "Penny Cyclopædia," 1836: —

CAMOUFLET or STIFLER, in military mining, is a small charge of powder sunk in the wall of earth between two parallel galleries, in order that by blowing the earth into one of them to suffocate or cut off the retreat of the miner who is at work in it.

"Camouflet" or "Camouflage" was used by the criminal classes in Paris, and I believe meant "to disguise or deceive," and it is clear that this is what was meant by "camouflage" during the war.

C. J. SEYMOUR BAKER.

OBITUARY.

CHRISTIAN WILLIAM LAWRENCE, D.L.—The death has occurred at his residence, Sandywell Park, near Cheltenham, of Mr. Christian William Lawrence, in his eighty-fifth year. He entered the diplomatic service in 1859, and, among other offices, he was Secretary of the British Legation in Stockholm, and British Minister to Ecuador. The last post he held from 1883 to 1890, when he retired. Mr. Lawrence was a magistrate and Deputy Lieutenant for Gloucestershire, where he was a considerable landowner. He was elected a member of the Royal Society of Arts in 1904.

GENERAL NOTES.

RECLAMATION OF THE PONTINE MARSHES.—A company has recently been formed, according to the *Anglo-Italian Review*, for the reclamation of the famous Pontine Marshes. The company's policy is based on drainage and canalisation of the mountain torrents which, after foaming down the gorges of the Lapini Mountains, spread over the plain irregular masses of rock detritus, thus forming a *terai*, which the absence of defined channels for the drainage of the water turns into dangerous breeding-grounds for the Anopheles mosquito. Canalisation is now in rapid progress, and as soon as the water is confined within banks it becomes possible to deal with the shrub-covered land. This is done with the aid of British "Fowler" steam ploughs, the only type found powerful enough to deal effectively with the strongly rooted brushwood. This levelling and aeration of the soil is expected to exterminate malaria in a very short time.

FLAX CULTURE IN RUSSIA.—The *Textile Mercury* of December 6th, 1919, contains some interesting particulars of the efforts which are being made by the Flax Growers' Association to extend the production of flax in Russia. Whilst the average yield of flax for the years 1903-1914 was 363,000 tons for Russia, the yield for all other European countries only totalled 116,000 tons. On the other hand, the average yield to the acre for Russia was only 300 tons as against 400 to 700 tons to the acre for other countries. The Association is now organising the peasants on co-operative lines, to restore and extend flax cultivation in the country.

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FRIDAY, MARCH 26, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

INDIAN SECTION.

FRIDAY, MARCH 19th; THE RIGHT HON. LORD CHALMERS, G.C.B., LL.D., in the chair. A paper on "The Indian Currency System and its Developments" was read by SIR WILLIAM S. MEYER, G.C.I.E., K.C.S.I., Financial Member of the Council of the Governor-General of India, 1913–18.

The paper and discussion will be published in a subsequent number of the *Journal.*

FIFTEENTH ORDINARY MEETING.

WEDNESDAY, MARCH 24th; SIR HENRY TRUEMAN WOOD, M.A., Vice-President and Chairman of the Council, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Bellamy, F. S., Teneriffe, Canary Islands.
Board of Trade, Great George-street, S.W. 1.
Cleghorn, Miss Maude Lina West, F.L.S., Calcutta, India.
Colvin, Sir Elliot Graham, K.C.S.I., London.
Durham, The Right Hon. the Earl of, K.G., G.C.V.O., London.
Green, Frank Ernest, Uxbridge.
Griffith, John Henry, Llanbedr, Merioneth.
Jones-Keith, W., Rouen, France.
Keller, Miss Frances A., New York City, U.S.A.
Mutch, Stanley Robert, M.A., London.
Osborne, Charles Haddon, J.P., Luton.
Pole, Major D. Graham, London.
Randell, Charles Edmund, London.
Sankey, Charles Herbert, Chislehurst, Kent.
Sutherland, Daniel Manson, Teddington.
Taylor, John Brown, Dundee.
Wren, Captain Frederick, M.G.C., Bedford.

The following candidates were balloted for and duly elected Fellows of the Society:—

Bond, Colonel Charles John, C.M.G., F.R.C.S., Leicester.
Gane, Charles, London.
Kahn, Otto H., New York City, U.S.A.
Kerfoot, Thomas, Gee Cross, Cheshire.
Murray, Victor F., B.Sc., London.
Pullin, Victor Edward, London.
Rawson, Thomas Gregory, Borrowash, Derby.
Reed, Clifford, Nelson, Lancashire.
Robarts, Harvey B., M.A., F.R.G.S., London.
Roberts, Joseph Henry, Rotherham, Yorks.
Tagore, Raj Kumar Nawab S. K., Calcutta, India.

A paper on "Industrial Lighting in its relation to Efficiency" was read by MR. LEON GASTER, Hon. Secretary of the Illuminating Engineering Society.

The paper and discussion will be published in a subsequent number of the *Journal.*

COVERS FOR JOURNALS.

For the convenience of Fellows wishing to bind their volumes of the *Journal*, cloth covers can be supplied, post free, for 2s. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

ELEVENTH ORDINARY MEETING.

WEDNESDAY, FEBRUARY 25th; THE RIGHT HON. SIR JOHN TUDOR WALTERS, M.P., in the chair.

THE CHAIRMAN, in opening the meeting, expressed his regret at the unavoidable absence of Sir Robert Horne, who was to have presided, and who took a close personal interest in the subject of the paper and in the work that Mr. Currie had been doing for some time past. He had personally had an opportunity of seeing something of the urgent necessity for industrial training in the work he had been doing at the Ministry of Health for the last two years. A great deal more trained and skilled labour was required by the Ministry than was available in the country at the present time, and if the scheme Mr. Currie was responsible for could so extend its operations as to provide the Ministry of Health with some trained carpenters, bricklayers, slaters, and plasterers, there might be a remote possibility of getting some houses built some day. The problem which existed before the war had been accentuated by war

conditions, and it surely could not be wise, from the standpoint of national health and efficiency, that so large a portion of the population should be inadequately trained or not trained at all in some useful technical art or handicraft. Many thousands of men during the five years of war conditions lost the ordinary opportunities of receiving industrial training, and it was the duty of the State to see that, in such measure as was possible, it made up for those lost opportunities. It was lack of education from the very commencement of life that was our most serious handicap. He believed there were tens of thousands of men and women who were willing and anxious to be trained, and if, by wisely directed State operations along the lines Mr. Currie and his colleagues suggested, they could be brought within the sphere of training it would be a great advantage to them. If they had abundant opportunities of receiving a skilled training it would enlarge their outlook, make their work less monotonous, and enable them to discharge larger and more important functions in the State, and it would be of benefit to all concerned.

The paper read was—

INDUSTRIAL TRAINING.

By JAMES CURRIE, C.M.G.,
Ministry of Labour (Training Department).

Industrial training of the type for which the writer of this paper has been to some extent responsible is the product of the war.

In the sense in which it was used during the war period it meant, speaking roughly, the training of men and women, as quickly as possible, to perform certain definite operations required in making munitions. When the war was over there remained the problem of finding new occupations for discharged and disabled soldiers who, unfortunately, were unable to follow their former trades, and not unnaturally the machinery which tackled the munition problem is now largely employed with the problem of the soldier.

The problems are, of course, not identical, the object of munition training being to train a specialist in one or two operations in the minimum period of time, that of the latter to turn out a skilled workman by means of intensive training in an abbreviated period.

The magnitude of the task imposed on the Training Department may be best gauged by the fact that it is estimated that a sum of at least twenty-two millions will be spent on this work during the next two or three years, and that from sixty to eighty thousand disabled men will be trained for the numerous trades in the various industries.

The particular schemes adopted have not been framed by Government; they represent the labour of joint bodies of employers and workmen, called National Trade Advisory Committees, which, in many cases, are affiliated to the newly constituted National Joint Industrial Councils.

Schemes have been prepared by practically all the principal English trades. For purpose of illustration I would refer to two such—engineering and building. In my opinion these are extremely important and interesting documents, as this is really the first occasion when the trades themselves have been responsible for the framing of what are, in effect, elaborate schemes of training for industry.

At this stage it is perhaps worth while to trace the evolution of the movement in some detail. In 1915, when the Ministry of Munitions was formed, the scarcity of skilled and semi-skilled labour was not among the least of the difficulties with which it was confronted. Dr. Addison, who at that time was in charge of the labour side of the Ministry of Munitions, conceived the idea that it might be possible to utilise the technical schools of the country to assist in meeting the great and growing scarcity of semi-skilled workmen, leaving the skilled workmen free for the more difficult operations. A small section was established in the Labour Supply Department of the Ministry of Munitions to organise the efforts of the local education authorities. Beginnings were made on a small scale, but it was not until towards the end of 1916 that the seriousness of the situation became manifest to every one, notably on account of grave labour shortage in connection with aero engine production, and Mr. Montagu, then Minister, gave categorical instructions that the situation was to be thoroughly explored. One of his last letters on leaving the Ministry in 1916 was as follows:—

"If I had remained here, I should have asked for an immediate investigation of the possibilities of increase, and I would recommend this topic as worthy of the immediate attention of those responsible in the Ministry of Munitions.

"I recognise the difficulties about the machinery, but I feel that even recalcitrant local bodies and private institutions, even the grave objections to considerable training in factories which are also producing, must be overcome, and we must make arrangements to turn out semi-skilled and skilled men and women at a far greater rate than anything yet achieved."

From that time progress was rapid, and training schemes assumed definite shape.

So far as the Ministry was concerned training was conducted under three categories :—

1. Training in technical schools.
2. Training in instructional factories.
3. Training in instructional bays attached to particular works.

Technical schools were under the management of local education authorities, financed and inspected by the Ministry of Munitions. Instructional factories were under the direct control of the Ministry. Instructional bays were under the management of individual firms, sometimes financially assisted by the Ministry, sometimes not. In no case was help given unless the trained product was mobile and available for work anywhere in the United Kingdom.

The development of training proceeded apace in proportion as the production engineer, with his gospel of manufacture on specialised repetition lines, gained general acceptance.

Prior to the outbreak of the war he had not, generally speaking, found convinced listeners, but the development of machine tools and the setting up of enormous establishments for the manufacture of articles for which there was an unlimited demand, revolutionised both technical and public opinion.

The history of the training movement, so far as it was successful, consisted—(*a*) in the acceptance, by the training section of the Ministry itself, of the production idea as the basis of their operations ; (*b*) in their education of the local education authorities along the same lines: this involved the equipment of the schools with modern machinery which would render actual production possible ; (*c*) in a similar process of evolution taking place among works managers and manufacturers.

At first the section fumbled rather blindly, preaching a gospel it half believed to a limited number of somewhat sceptical adherents. It owes its technical salvation to some half-dozen production engineers—to Mr. Purdy and Mr. Buscard, representatives of leading American machine-tool manufacturers; to Sir Alfred Herbert and Mr. Oscar Harmer, of Coventry ; to Mr. Schofield, Principal of Loughborough Technical College ; Mr. J. L. Hall, of Coventry ; and Mr. Binns, formerly district secretary of the Amalgamated Society of Engineers in the Manchester district.

These men were quick to see the possibilities of the movement and ready to assist it. Conferences were arranged between education authorities, principals of technical schools, and the gentlemen named above, and a clear understanding arrived at as to methods and objects.

Progress subsequent to that conference was continuous and vital. Needless to say, many obstacles were encountered. Trade Union prejudices, or perhaps it would be fairer to say rank-and-file fears due to a variety of causes, undoubtedly retarded progress. Bad works management in the hands of men to whom the production idea was totally unfamiliar constituted another serious difficulty. Such officials merely saw in it a convenient method for tinkering with wages and were blind to the possibilities. It was impossible to convince them that unless they could furnish the Training Department with a detailed analysis of the methods by which they proposed to attack any particular production problem, the whole idea of intensive training at once broke down. It is almost no exaggeration to say that the higher the standard of production attained by a firm, the more intelligent the use made by them of the trained men and women who were sent to them.

But, in the main, the general idea gained acceptance, and progress was continuous. The men and women trained were of all types, varying from country girls with a good Scotch education from Aberdeenshire, anxious to help the national cause, to textile engineers in Lancashire, whose general education, thanks to the cursed half-time system, certainly left something to be desired, anxious to take their chance of being up-graded to more ambitious forms of machine-shop work. In all, at least 50,000 must have graduated through the training establishments into one form or other of war production. Generous testimony was borne by many firms as to the help they had received Most gratifying of all may be quoted a letter from the Department of Aeronautical Supplies, which states :—

"I should like to take this opportunity of thanking you and your Department for the exceptional services rendered in connection with the training and supply of labour. We are certain that if it had not been for this effort, the supply of aeroplanes and aero engines would have been very seriously retarded, if not altogether held up."

When the Armistice was proclaimed, the Ministry had equipped one hundred technical schools with first-class plant, and possessed nearly a dozen large instructional factories, each capable of holding from 400 to 800 learners.

But meanwhile a second problem, and one, in

many respects, of greater difficulty, had been developing. The disabled soldier, steadily growing in number, was asserting a claim to employment. Training in some form or another was clearly necessary for him, but training of a widely different character and with different objects from munition training. It was clearly useless to attempt to train the soldier for work of a temporary nature. What he desired was permanent employment, and for him work under dilution conditions was, from the individual standpoint, really a snare, however highly paid, or however desirable in the national interest. It was necessary, if possible, to devise a system under which he might become a skilled craftsman and be admitted to the ranks of skilled men. This obviously involved negotiations with both employers' organisations and trade unions, and under the general direction of the late Mr. St. George Heath, at one time Warden of Toynbee Hall, and of Mr. D. T. John, of the Ministry of Labour, a series of negotiations were conducted during 1916 and 1917 with well-nigh all the leading British industries. The results of these negotiations were embodied in a series of agreements, to which representatives of employers' organisations, trade unions, and the State were contracting parties. Under these agreements the interests of all were, as far as possible, duly safeguarded—the rates of pay the disabled man was to receive, the amount of State contribution, and the regulation of the number of men to be admitted to any industry—all these considerations were provided for.

Further, at an enormous expenditure of time and labour, these special representative training committees, *i.e.* the National Trade Advisory Committees, composed of employers and workmen, were charged with the duty, not only of devising schemes of training, but of supervising them after they had been devised. These schemes, in their complete state, all have one common feature, viz., a preliminary period varying in length from six to eighteen months to be spent in some technical school or instructional factory, and a further period of eighteen months as an improver in works, at the end of which time the training would be completed and the man would be eligible to become a member of the appropriate trade union. There were also established Local Technical Advisory Committees, constituted on a basis similar to that of the National Committees, whose functions were to select the men for training and to supervise their progress during the period of training. By this means the co-operation and advice of those actually concerned with a particular industry, both nationally and locally, were obtained.

It will readily be recognised that a fundamental feature of the training of disabled men is that careful selection be made, so that a man may be trained for a trade suitable to physical and temperamental disabilities. For this purpose the need for expert technical advice is apparent.

In 1919 the Government decided to take up this question of training on a large scale; in fact, it figured as a definite plank in the platform during the 1918 election. All industrial training was taken over by the Ministry of Labour, in which it formed a separate Department. The *personnel* of the old Training Department was largely represented in the *personnel* of the new Department.

Women, in addition to disabled soldiers, came into many of the schemes. Many thousands of women who had given the apprenticeship period of their lives to the making of munitions, instead of learning some typical woman's trade, found themselves out of employment. It was difficult for them to get absorbed in any of the typical women's industries, as the employer, if staff had to be taken on, naturally preferred the young girl, who was more adaptable and who would not expect the wages of an adult woman. For this type of woman intensive schemes of training had to be devised, which after a brief period would render their admission into typical women's occupations, at reasonable wages, an economic possibility.

It has been calculated that the number of disabled men who will require training facilities is not far short of 80,000. At first it was hoped that it would be possible to arrange for the vast majority of the number by directly placing them in work at the same time making provision for part of their maintenance during the "improver period"; but as the majority of the National Trade Advisory Committees proceeded with this work they became more and more impressed with the necessity of a moderately long period of preliminary training in something corresponding to an instructional factory, winding up with eighteen months as an "improver" in works under careful supervision.

From a Treasury viewpoint, and it may be added from the standpoint of many of the disabled soldiers, this is an unfortunate development. Why, the Training Department is often asked, is the disabled man not sent straight

into works?—on the analogy of the ordinary apprentice—and he can be trusted to absorb the craft by degrees. Unfortunately, the disabled soldier is not a boy but a man, who is endeavouring to do in three years what takes a boy five or six. Experience has convinced all practical men that it is vain to hope for the success of the soldier in an average shop, unless he goes in equipped with sufficient knowledge to enable him to take an intelligent part in actual production.

In the case of very large firms, no doubt instructional bays could be established and treated on the lines of instructional factories; but that would not affect the principle that instruction and production will not blend, but must be kept separated from one another. Under the instructional factory system that divorce from factory life is avoided which, from the point of view of adult training, may be considered the defect of the technical school, and the concentration on production, which from the same standpoint is the defect of the factory.

In the instructional factory the primary object is not the production of components or finished goods, but of skilled men, and it is the chief duty of the manager and of his instructors, who are the equivalent of the charge hands or foremen in the factory, to train men for particular branches of industry by methods of approved utility. The work in an instructional factory takes a practical form from the start; the "preliminary exercises" of a technical school being replaced by simple forms of production work, chosen from the point of view of their value for training purposes, from which the learner passes forward in due course to the more advanced processes. In this way an impression of reality is created and interest aroused. This form of training also provides opportunities, informal or otherwise, for imparting a knowledge of the fundamental principles underlying the various skilled operations, such as can rarely, if ever, be given in the ordinary workshop. Moreover, the instructional factory, working to normal factory hours and with normal factory discipline, affords an invaluable introduction to workshop life, and the worker when transferred to a firm at the conclusion of the training course finds himself in an environment with which he is already very largely familiar.

Briefly, it is claimed for the instructional factory system that by its means a high degree of proficiency can be acquired more rapidly and effectively than through any other system of training, whether in technical school or workshop, than has as yet been tried.

It is no exaggeration to say that this attitude adopted marks a revolution in the several industries as regards the opinion formed of the possibilities of training for actual work in places outside the works themselves. The engineering trade led the way, the reason for this being that they had had a better opportunity than most of the other industries of studying the possibilities of the system during the five years of war.

The National Trade Advisory Committee for the Engineering Industry, which prepared the training scheme, was as representative of the industry both on the side of the employers and workpeople as any body of men could possibly be. They made an exhaustive examination of the various instructional centres; I quote the Chairman's report on one of the centres of which a particularly exhaustive inspection was made:—

"I was very much impressed with my visit. I think it is ideal and you have got the right man in the right place looking after it. If all technical colleges were like that, we should be at the top of the tree. If you could only get other technical colleges formed with equally good men to look after them, you have solved a most important question and rendered a national service to England.

"There are only two points that I consider require most careful consideration and must be faced. The first one is: a certain sum must be put by every year for depreciation, so that the machinery in these technical colleges may be kept up to date. It is not sufficient to put up-to-date machinery in, but the machinery must remain up to date. The second condition, which is equally vital to my mind, is that the work done by the students, or whatever you like to call them, who are working in the college, must be commercial and done at a fixed price, so that students and foremen may realise that the work that is done must be done not only well, but cheaply."

The writer of this paper is far from saying that the question of training disabled soldiers is anywhere near solution, but if premises can be acquired with sufficient speed he is distinctly of opinion that a great part of the problem is capable of solution. But the main point on which for the moment he desires to lay stress is, that all the great industries of England have been forced to conduct an exhaustive analysis of their own methods, and have been themselves primarily instrumental in laying down (and are responsible for supervising) the methods by which in the shortest time a skilled man can be evolved. It might perhaps be advisable to

examine here in detail the conditions which determine the type of training given in the trade which will probably be of most importance in the future—the engineering trade.

It should be recognised as a fundamental fact that the type and amount of skill required in any industry, in any period, exactly corresponds to the degree of accuracy of the measuring tools of that period. In the engineering trade, for example, thirty or forty years ago it was the practice to measure articles with a tool called the caliper, which is really two pieces of steel fastened together and swivelling on a pin. Here the accuracy in measuring was dependent on the skill of manipulation of the calipers, and to gauge the size of a shaft required a great deal of skill on the part of the man. He had to develop what is known as a correct "feel." His accuracy was limited generally to just under the thickness of a paper, although the old time mechanic, where the measurement was a relative one, could gauge its size to an extraordinary degree of accuracy; but, whilst he could tell by "feel" with the calipers the difference between, say, two shafts, he would be unable to register on paper the exact difference between them. The secret lay essentially in the lightness of touch of the mechanic. To-day the modern schoolboy can measure with a far greater degree of accuracy with instruments that not only neutralise the difference of "feel" between two individuals, but also register on a dial the correct amount of difference between various articles measured.

It should be obvious from this example alone that the methods of technical education required to-day differ enormously from those required, say, thirty years ago. Again, the old type of mechanic was frequently asked to repair an engine, and because of the fact that measuring instruments were not sufficiently developed to allow two people to make their work interchangeable, he was accustomed to complete the job himself—turning, shaping and fitting operations would all be done by the same man. You had in those days what I might term a formula—

Simple Machine – Skilled Labour.

To-day, through the development of measuring instruments and machines, and of semi-automatic and automatic machines, hundreds of parts are turned out by different men, every part of which is interchangeable. It will thus be seen that, generally speaking, the old-time mechanic is no longer an industrial requirement, except for highly intricate forms of tool-room work. Technical education to-day requires the production of a useful unit of industry. To be modern, one must train to suit modern requirements and successful technical training requires close co-operation with the modern factory.

A brief statement of the procedure adopted in one of our engineering factories, both during the war and at the present time, should explain exactly the principles involved.

At Twickenham we have an instructional factory devoted entirely to engineering. This factory is equipped with the most modern machinery obtainable. Perhaps the point on which most stress should be laid is that not only is the factory equipped with the most modern appliances used in engineering, but the whole of the atmosphere of the institution is that of the workshop. The chief aim has been to eliminate, if possible, what is known as the "school" atmosphere, and develop factory conditions, so that after the person in training has finished his course he is not only trained in the technique of the industry, but he is familiar with, and able to fall readily into, the usual customs of the trade. His instructors are known as charge hands. He has foreman, works manager and superintendent. He makes out time sheets, and "clocks in" and "clocks out"; so that, when he enters the modern factory he enters as one who is thoroughly familiar with his surroundings and its procedure.

During the war this factory was utilised for the purpose of training women on munition work. The main work of the factory was the production of aeroplane engines, particularly the "Le Rhone" type. The problem facing us at that time was an insistent demand from the factories for a large and speedy supply of people able to do only one or two operations on this type of engine. In the factory one particular operation of the engine would be done by one operator, day in and day out, and the demand from the factory was not so much for a person able to manipulate a particular machine as for a person able to perform a particular operation. This demand was supplied, I think most successfully, by the adoption of exactly the same system in producing the engine as was carried on in the factory requiring the trained persons.

Take a concrete example. What was known as the T piece for the "Le Rhone" engine was done on a Herbert No. 4 capstan. The firm required women capable of doing this T piece. Twickenham factory had a large battery of Herbert No. 4 capstans, and promptly placed the girls in the factory to do these T pieces. They would be given instruction in the art of measuring with

calipers and also with the micrometer. The girl would also be given some elementary notion of tool-grinding, but her main work would consist of turning T pieces. When she left the training factory she left as a competent capstan operator, able to manufacture T pieces and jobs of a like nature.

When it is realised that we had to produce in the short space of three months operators of this type, I think it will be agreed that it was absolutely necessary to specialise up to the hilt. Our problem was to take a girl who had been accustomed probably to nothing but housework, unaccustomed to factory life, and who generally estimated an inch as being equal to the length from the tip of her thumb to the first joint, and make her thoroughly acquainted with the most modern methods of measurement, and also to break the disciplinary conditions of factory life as gently as possible to her. This could only be done in such a short time by the adoption of a National Training School whose conditions were exactly similar to those of the ordinary factory.

To-day, however, the problem is somewhat different. We are asked to train men and make them skilled mechanics. Disabled soldiers, who for some reason are unable to follow their own particular employment, are to be made efficient in a number of trades, amongst them being engineering, and whilst, as already stated, the problem is somewhat different from that of training women for munition work, it is a difference of time rather than technique; for, as already indicated, the type of mechanic required to-day is vastly different from the mechanic of forty years ago. Mass production is the order of the day, and its success depends essentially on the specialisation of labour.

Modern requirements in engineering demand a specialised fitter or turner as the case may be, whose greatest qualification is speed rather than quality. We have now the formula—

Simple Labour – Skilled Machine,

and our chief aim at Twickenham at the present moment is to produce not a mechanic with little bits of theory sticking out all over him and with a slight knowledge of everything connected with the industry, but an efficient workman in a particular trade.

A man who is to be trained in turning, for example, is given a few lessons in measuring instruments, machine drawing, and elementary mathematics. He is then placed upon simple operations involving turning articles to size, and he learns as he works. That is to say, he is placed upon a machine, say a lathe, and given a job to do. He is not only told what it is for and how to do it, but he is expected to do it under conditions exactly similar to those he would be called upon to work under in modern factory life. He is given everything that he will require to become a practical man and an economic unit in his trade.

We have reached the stage, I hope, when it is recognised as being a waste of valuable time to teach a man who is destined to work in tools the elements of civil engineering.

A point worthy of notice is the fact that from the moment our trainee is placed in the factory to the time when, equipped with a full set of tools and a good knowledge of his trade, he leaves the factory, he has never once been asked to do a useless exercise. All the work that he has performed has been of a useful character, and calculated to develop his interest in the work in hand. It is the complaint of many engineers of to-day that the major portion of the time spent by them in technical schools was devoted to exercises involving the fashioning of metal into all sorts of obviously useless shapes. Nothing is more calculated to destroy a person's interest in his labours than the knowledge that the material on which he is working will find its home in the scrap heap. Useless work of an exercise nature, then, is excluded, and the essence of our training is the equipment of men in the shortest possible time with sufficient knowledge and skill to enable them to take their places side by side with the craftsmen of to-day, and earn by their own exertions the recognised rates laid down by the trade unions; and the key-note of success in this direction is the adoption of training schools with plant and methods of production equal to those of the most modern factory.

The reason for the slow progress in production methods in England prior to 1914, was due to the fact that this critical analysis had never been carried out before by industry as a whole.

It would appear likely that this training work, so far as the discharged soldier is concerned, will go forward vigorously for some three years. The Advisory Committees, both national and local, will be functioning vigorously during that period, and instructional factories capable of holding some 20,000 men at one time will be in operation within a comparatively short time.

It is well at this stage to observe that although the general training work is centred in the Ministry of Labour, a great deal of the administrative work is carried on by local education

authorities, and that in many of the most important areas into which the country has been divided, the Ministry have been fortunate enough to secure local directors of education as their administrative officers.

Whatever demand the future may hold for adult training, it is quite certain that the problem of training the youth of the country between fourteen and twenty has not yet been faced.

The Fisher Act may be taken as the first acknowledgment that such a problem exists, but the attempts to put a part of it into operation are not much more than tentative.

That Act provides ultimately for the extension of part-time education of juveniles and adolescents to as high an age as eighteen. In my opinion many of the large population which will be required or entitled to receive such education will not be content with any form of instruction which is not largely vocational, and the instruction must be on lines which will appeal to the working-classes, both parents and the actual recipients, as of direct practical bearing upon their occupation.

There are two other possible directions in which the new system of vocational training may be of value. One is in the re-education of the cripples of industry, the other is the training of men and women thrown out of employment through the fluctuations of industry in the trade on which they have first embarked, for other callings.

As to the first point, it is interesting to note that the French are already considering the diversion of some of the training centres established for the training of disabled soldiers to the training of men injured in industry. If, for example, a soldier, who was formerly a mechanic and through injury to his legs is unable to continue to pursue his trade, can be trained in precious-stone cutting and thus become a contented and productive citizen instead of a discontented burden upon his family, his industry, or the community, there is no reason why the same process should not be applied to the rehabilitation of civilians rendered incapable by industrial injury of following their previous trade. No doubt the great shortage of man-power from which France was already suffering before the war has made this problem to her a more real and pressing one than it is as yet in this country, but in England, too, the present serious shortage of skilled labour, which has largely been caused by the ravages of war, may make it necessary to tackle the problem of the cripple in industry in the near future, even apart from the increasing effect of what may be called humanitarian considerations and the increasing recognition of the duty of the State to those who are incapacitated in its service.

As to the second point, the Ministry of Labour have found in several instances—for example, the clothing trade in Yorkshire—that skilled men and expensive buildings and machinery were standing idle simply and solely because there was a shortage of semi-skilled women to carry out certain parts of the work, for want of which the skilled men were idle and the plant could not be employed. We have found it possible, by training women to perform less skilled parts of the work, to fill the gap and to bring the skilled men and the machinery into operation. I need not enter here into the reasons for which it was found practically impossible for the employers, without State intervention, to fill the gap themselves.

The Insurance Act of 1911 contained an interesting forecast of this possibility, for it contained a clause which enabled the Board of Trade to arrange for the training of unemployed persons where they were satisfied that such training would enable them to obtain employment. So far as I know, neither the Board of Trade nor the Employment Department of the Ministry of Labour, who took over their responsibliity under the Insurance Act, were able to put this clause into operation. It was only under the strong compulsion created by the Armistice, when large numbers of women were thrown out of work through taking on munition work at an age when they would ordinarily have entered some peace time avocation, but were deprived of their normal opportunity of learning a trade while they were still young, that the State was driven to tackle this problem.

The welfare work done in the Ministry of Munitions may be said to have killed stone dead the theory that to throw a lad into a large works and leave him to pick up what he could was any other than a villainously wasteful method of evolving a skilled man, to say nothing of a good citizen.

What was in existence in 1914 was really reminiscent of the old apprenticeship system, under which the boy lived with his master and worked on the very varied jobs as they came in. It was an excellent system, there was a personal tie between the two, the boy received an excellent discipline and a good all-round craft training. It was suited to an age of small private production. It still survives under

satisfactory conditions in the case of the village blacksmith, wheelwright, or small builder.

But this patriarchal condition of things, while it may still function in a country village, is in the main unsuited to an era of huge works and mass production. Personal relations between the employer and the apprentice ceased to exist, and no substitute was provided for them. The whole conditions of teaching the trade altered; but it ceased to be the particular interest either of the employer or the workman to teach the unfortunate apprentice.

The question of what a skilled man should learn, nay more, what constituted a skilled man, was never faced. Even the best employers were satisfied with the old methods of the workshop, and at most thought it sufficient to supplement them by technical and general educational classes. These were good in themselves, but they left the problem of the sequence of training inside the workshop entirely untouched. With English production in the chaotic condition I have described, the problems of 1914–18 had to be faced.

I have described how the Ministry of Munitions attempted to face them. I do not say that their methods were perfection. So far as training was concerned I now believe we might have done better had we done more in the direction of scientifically upgrading in the industry itself. We might have done more in the way of introducing the textile engineer, who had already served an apprenticeship in his own branch of the industry, to the higher walks of engineering, and had we done so we should have encountered less opposition and prejudice than we did. But it seems to me that we established one fact beyond the possibility of doubt, and that was that the waste of time and life in the existing system of craft apprenticeship was beyond computation.

And though our further task of creating a skilled man by the application of intensive methods has not yet reached a stage at which it is possible to talk dogmatically as to possible results, the schemes themselves, which, be it remembered, are the creations of representatives of the industries themselves and not of any bureaucratic Department of State, would seem to warrant somewhat similar conclusions.

The particular point on which I desire to lay stress (and this is the reason why I have written this paper) is to point out that, say, in 1924 at the very latest—by which time we hope that our debt to the disabled soldier will have been discharged, so far as it is possible to discharge it, by means of training—there will be in existence a complete machinery of instruction in every skilled industry in England, and that the joint managers of these industries will be the industries themselves and the State. There will also be by that time, I would hope, chairs of industrial production method in all the new universities and higher technical colleges, while the extension of the school age and the developments produced by the Fisher Act generally, will have raised the whole standard of the entrants to industrial life. In addition, increased wages and a higher standard of living will have rendered the elimination of waste from industry a matter of sheer economic necessity; it will simply not be able to afford the old chaos.

What I plead for is the necessity of watching with the utmost carefulness the results obtained from the present unparalleled experiment. It also appears to me that this experiment has a direct bearing on certain aspects of the unemployment problem. The problem of training the unskilled, and of transference from one industry to another, is clearly not of the hopeless character we were taught to think it.

We are not saying too much if we assert that if we can only reconcile the legitimate interests of particular trade unions with the interest of the common good, we can see daylight through many dark problems. Before that can be done a satisfactory solution to this problem of unemployment must be devised. We must therefore confine ourselves at present to the assertion that the possibilities of transference from one occupation to another are far greater than, before these experiments were commenced, anyone thought them to be. But, as I have always said to my friends at the Board of Education who shrink from the prospect of hearing temples of learning echoing with the din of industrial disputes, the real interest of education lies in the fact that from time immemorial it has been the subject on which the whole world draws knife; nor do I believe that either Mr. Smillie or Mr. Brownlie, Mr. Clynes or Mr. Thomas, can be found more troublesome than the tribe of warring theologians who in the mid-Victorian days were the lions in the path of progress. Considering that the interests primarily involved will be those of their own children, I confidently rely on the intelligent support of Labour in this problem of Training for Industry.

DISCUSSION.

Mr. W. R. Davies, C.B. (Board of Education), said he desired to speak entirely for himself and not for the Department with which he was connected. He was sure everyone present had been very much interested in the author's enthusiastic presentation of the subject, and personally he did not wish to say a word against the claims that the author made as to the success of the schemes for training munition workers, apprentices, and disabled soldiers. He thought, however, that what the author wanted all those present, and himself in particular, to think about was the lesson that the work in question had for those whose lot it was to deal with the industries of the country and the training of the people engaged in those industries, and personally he wished to have the widest opportunities of seeing the work as it progressed. He had spent a certain amount of time in an institution dealing, not with the training of the rank and file, but with a somewhat different subject, the training of the leaders in industry—the production of engineers. He thought the author had been speaking about the rank and file, machine operators, and so on, and he agreed that it would be foolish not to make the very best use possible of the experiments the author dealt with—for they were experiments in their bearing on some of the problems of the future, although they had been very successful for their particular purpose. We ought to consider how what had been achieved could be incorporated into our national life, our national system of industry, and our national system of education. But when one came to practical propositions there were one or two points that it happened to be his business to think about and that he would like to bring before the meeting. At the present time the State was about to spend something like £40,000,000 a year on education, and a great deal more was spent by the ratepayers. Of that £40,000,000 not much more than £250,000 went directly to anything that could be described as technical education, apart from what was done in the universities. The author had stated that about £20,000,000, possibly more, would be spent in the next few years on the instructional factory training of disabled soldiers and apprentices.

Mr. Currie pointed out that that sum included maintenance allowances.

Mr. Davies, continuing, said he believed the training was full-time training, and up to the present nobody had ever suggested that the educational system of the country should include a universal system of full-time training of a technical character for young people who at some later time were going to enter the various industries of the country. That sort of training was only provided to a very limited extent. There were no maintenance allowances, either for those in secondary schools or for those in technical schools, except so far as individual local education authorities, representing the ratepayers, might think it desirable to provide those allowances for promising young people. The expenditure of the London Trade School for Girls was about £20 or £25 a head per year—possibly a little more at the present time, owing to the increased salaries paid to the teachers. He had seen an instructional factory and had heard something about the cost of the machinery it contained, and had heard references to depreciation and obsolescence. Speaking frankly, if the suggestion was that boys should only enter the engineering industry *viâ* the instructional factory, or that a very large proportion of the boys entering the industry should do so in that way, he considered the instructional factory ought to be an instructional bay of the works, run by the firm concerned and not maintained by the taxpayers and ratepayers of the country. If employers, engineering employers in particular, were satisfied with the results of the scheme of industrial training which came into existence during the war—and he had every reason to believe they were—they might think it worth while as a business proposition to undertake similar work themselves if their firm was large enough to do so.

Mr. W. A. Brockington (Director, Leicestershire Education Committee) said he was very glad that the author looked beyond our present difficulties and discontents to the future bearing of his system of training upon our education policy in general. At present one was oppressed with the difficulty of its application to the trainee, the initial difficulty of allocating the right number of trainees to any particular industry, and the even greater difficulty of getting those trainees placed after their institutional training and during what was known as their improver period, and he was glad that the author had looked beyond those difficulties to the future. He was inclined to agree that, whatever might be said of the demand for non-vocational education in our continuation schools, for example, when that education was extended right up to the age of eighteen—as it would be after seven years—there would be a very considerable demand that it should have some relation to the real interests and daily occupations of the students. To that extent such education must be vocational. He did not think that, when what had been done in industrial training was applied to our general education policy, it would have so much relation to day continuation schools as it might have to the higher whole-time type of education. There was room in this country for one or two institutions which combined the teaching on

the mathematical and physical side of engineering with very definite workshop practice, and he hoped what had been done in the past would be applied to the future of education in that direction. There were one or two points that very clearly emerged from all that had hitherto taken place. They were not new ideas; they were old ideas that had been very strongly developed in the minds of many of those who were concerned with education. One of those points was the idea of training upon production, an idea which permeated the elementary schools of this country, where classes were held in cookery, dressmaking, woodworking and metalworking. That added a very great interest to the life of the child. If carried forward to anything like an advanced engineering training that idea would prove very expensive, but was the expense commensurate with the object in view? He thought it was, and that it was a very good thing to experiment along the lines towards which one was directed by that single idea of training upon production—half-time workshop practice side by side with class-room training on the physical and mathematical side of a great industry like engineering. He therefore hoped that the difficulties with regard to expense caused by depreciation of machinery and other matters would be overcome. Another point that had emerged very clearly was the idea of localisation. Those concerned with technical schools had from the very beginning tried to get them into actual touch with the industrial atmosphere of their own neighbourhood. Owing to lack of funds and other reasons that attempt had not been successful in the past, and technical training had to a very great extent lagged behind the actual requirements of the neighbourhood. The technical school, therefore, had not always been looked upon with respect by the manufacturers in the surrounding districts. The idea of localisation, however, was very strongly held, and he believed that the foundation of the local technical advisory committees —which, after all, were only the old technical advisory committees that most really advanced education authorities set up to help them in the various industries—would be a very great help in the future to the cause of education, because they would bring together experts in every particular branch of industry who might be counted upon to explore the needs of the industry and to educate the education authorities.

Mr. H. Purdy said he had spent most of his life in the United States, but he returned to England in 1900 to represent a leading American firm and see if there was any prospect of doing business in this country. He went through many works in Birmingham, Manchester, Newcastle and other places, and he had been astonished at the high efficiency of the labour and the low efficiency of the plants. In many cases the firms did not know the definition of production. One component part had no relation to another from the point of view of standardisation. A sporting gun made by any big firm in England might be a beautiful gun in itself, but owing to lack of interchangeability it might be difficult to get a spare part for it if one wished to do so. At the time he visited England in 1900, bicycles were being imported from the States, where labour and material were both more expensive than in this country. A number of British manufacturers studied the American methods, and within a few years they were making a much better and cheaper bicycle than was made in the States. If that could be done with regard to bicycles it could be done in sewing-machines, motor-cars, typewriters and other lines of a like nature. When the British Government wanted rifles during the war, firms spent money on the necessary plant, with the result that the manufacturers in this country made better and cheaper rifles than were made in the States. The brains were here; England did not have to send to America for them. He had been working with the author of the paper for four years, and had the greatest admiration for him. It was astonishing how he had grasped the mechanical possibilities of England. The boys of this country had the best possible brains when they were trained aright, but why pitchfork them into miserable factories that spent thousands of pounds in keeping the daylight and fresh air out? Actual production was more or less monotonous. There were enormous numbers of unskilled men unemployed; the parents of many large families could not apprentice their boys, for when the lads were fifteen years old they had to help to keep the younger children. This type of unskilled men were the men that actually obtained the production, but the means of obtaining it were in the hands of the highly skilled men. Unlike the actual production, the means of obtaining production were exceedingly interesting. In the factory with which he was connected in America, a great percentage of the workmen were Scotsmen and Englishmen, but they were much more efficient than they were when they left home, owing to working under more efficient conditions and in a different environment. It was often said that highly efficient machinery was too expensive, and many firms worked on the lines of buying low efficient and cheap machines, trusting to the high efficiency of the operators to obtain results. He contended that all the technical schools should be supplied and maintained with completely up-to-date machinery. The low efficient machinery was not only a waste of money, but was also wasting the time of the young men and handicapping their whole future.

Lady Parsons said she had very much enjoyed listening to the author's interesting paper. Women highly appreciated all that the author did for them during the war, by helping them to obtain employment in engineering works, and by successfully devising dilution schemes. The sum of £22,000,000 had been mentioned in the paper as the estimated amount to be spent on technical schools, and she would like to ask whether a little of that might be spent in training women, not in domestic science or laundry, or anything of that kind, but in making them efficient units of such an important industry as engineering. She would also like to know whether, if that was done, there would be any prospect of those trained women being allowed to sell their labour, so that women too might participate in the improved conditions of life that men were claiming with so much insistence. The welfare work and improved conditions in factories that had been brought about were due to the entry of women into the factories during the war—if any air, light and sunshine were now admitted, it was owing to the women; but now they were on the scrap-heap, whilst the men were enjoying the improved conditions that the entry of women had obtained for them.

Mr. Currie, in reply to Lady Parsons, said that with regard to the question of women in engineering works, it might be desirable to see them there, but it was hardly his business, as a Civil servant and a member of the staff of the Minister of Labour, to forecast the future. The second question Lady Parsons had asked was a hypothetical one; he thought she might put it again after a year or two had elapsed and the dilution pledges had been honoured.

Mr. G. E. Hart said he had been very much interested in the paper. As one who had taken a good deal of interest in the training of a number of boys, he took it that the first object was to obtain efficient workmen. He could quite appreciate what had been said in regard to the intensive training of wounded soldiers, because he was actively interested in that work. It must be borne in mind that the trade union rules were withdrawn during the early time of the munition training, and that the rules and regulations laid down by the National Committees of the various trades provided an excellent scheme, not only for training disabled men in particular trades, but also for assuring them permanent employment at the end of their training. Many people had said: "Why train a man for three or four years, when we can teach them to do certain things in a year?" The answer was that a man could not learn a skilled trade under such conditions, and even during intensive training a certain period of time had to be allowed. So far as the printing trade was concerned, that period of time had been arranged as between the skilled workmen and the employers. The periods varied in the different departments, and ranged from one year to four years. The disabled soldiers entered the trade with a clear perception that they had to provide for themselves and their families, and it was only fair that they should be given such a training as would enable them to enter the craft just as well equipped as the ordinary apprentice was when he came out of his time; otherwise intensive training would be useless. When boys came into the printing trade at the age of fourteen, their education was such that they were not fit to be employed for a year or two after their admission to the factory, and the consequence was that, for the first two or three years of their apprenticeship, they were merely errand boys, instead of being able to take up their craft and learn it right away. He therefore thought that boys should, for the first two years of their apprenticeship at least, have such an extension of their ordinary elementary education as would fit them for the trade in which they were going to obtain their living, and even before they left school at the age of fourteen there should be some kind of bias towards that trade. So far as the workshop was concerned, he thought that national workshops for particular trades would be very largely a mistake. First of all, a boy should receive a general education which would fit him for the trade he was going to enter, and then his education should be continued in the technical school and in the workshop combined. It was no good putting a boy into a shop where he knew that the work was not on a commercial basis. He should become acquainted with the varying conditions in an actual workshop, and with the varying grades of work which no national workshop could afford to provide. He wished to lay stress on the need for specialised education for the boy in addition and prior to that which he received in the technical school.

On the motion of the Chairman, a hearty vote of thanks was accorded to the author for his interesting and instructive paper, and the meeting terminated.

WATER-SUPPLY IN JERUSALEM.

The question of water-supply has always loomed large in the history of Palestine. The geological formation of the country accounts for the fact that very little water remains on the surface of the ground, the winter rains percolating quickly through the fissures and crevices. No rivers exist in Palestine, except the Jordan, and there is very little rain during seven out of the twelve months of the year. Once a prosperous agricultural region, it is now a barren waste, largely through the Turks having stripped it of its trees.

A book could easily be written to describe the interesting part which water-supply has played in

the history of Palestine. Hezekiah was instrumental in tunnelling a conduit 1,750 ft. long through a limestone hill with a view to effecting local improvements; and Solomon, Pontius Pilate, and Herod were amongst those who attempted to get a supply of pure water into Jerusalem. It remained for the British Army engineers to do the job successfully in a little less than seventy working days.

The supply of water for Jerusalem is obtained from the springs at Arub, 16 miles to the south of the city and beyond Bethlehem. A wonderful piece of work done by the engineers of ancient Rome was the development of these springs in the form of a gallery, and collecting and conducting the water by an aqueduct into a stone reservoir with a capacity of about 5,000,000 gallons. This reservoir was situated at a distance of some 2,000 ft. from the main spring. From the reservoir the water was conducted to the centre of Jerusalem by an aqueduct which stands almost intact to this day.

British engineers have put the spring and reservoir into service again. The water is now elevated by a pump worked by a 66-h.p. gasoline engine into a new reservoir at the top of an adjacent hill, over 500 ft. above the Temple site in Jerusalem.

Practically every house in the town has its own rainwater cistern, but most of them were found to be in a filthy condition—one had not been emptied and cleaned for nineteen years. The owner of a cistern must now obtain a certificate to prove that it has been put into a thoroughly sanitary condition before it can be filled with pure water from the new supply. The organised effort to provide water for the 50,000 inhabitants of Jerusalem has enabled them to have ten times more than formerly. The picturesque water-seller, with his pigskin pack, will soon be a memory of the past, as also will be the figures of the charming native ladies carrying jars on their heads. What is more important is the improvement of the health of the community, and it is to be hoped that there will be no more of those terrible water-borne diseases such as were so common when Turkish rule prevailed.

INDUSTRIAL LABORATORIES IN ITALY.

Appreciating the importance of applying scientific methods in its industrial development, if it is to solve successfully the great problems of reconstruction and to meet competition from other nations whose industries are more highly organised, Italy is devoting special attention to the questions of industrial experiment stations and of technical education. The necessity for such action is made more urgent by the adoption, in many industries, of an eight-hour day. If the working day be shortened to eight hours, increased efficiency in manufacturing methods must be brought about if production is to be maintained.

In this connection the Italian Government, together with the manufacturers, is establishing experiment stations for the principal lines of industry. In addition to studying new processes and making new applications of old methods, these stations will supply the industries with a trained *personnel*.

According to a report by the United States Trade Commissioner at Rome, four stations have been established—two at Milan, for paper and fats respectively, and two at Naples, for leather and ceramics. Another is being established at Reggio Calabria for essential oils and perfumes, and three more are to be established as follows: At Rovigno, for the sugar industry, in connection with the existing school of beet culture; at Milan, for the development of the refrigerating industry; a third, probably at Rome, to study the distillation of gases and their by-products, and, in general, all the processes of combustion. One section of this last-named station will devote itself to the question of the utilisation of national fuels and lignite. Later on consideration will be given to the creation of stations, on the initiative of the manufacturers, for the electro-technical and photo-technical industries and for dyestuffs.

In order that the standard of vocational education might be raised, provision was made at the end of 1918 for the establishment of laboratory schools. At first there will be twenty of these schools, of which two will be at Milan. In addition to a Government subsidy of 25,000 lire each, the laboratory schools will receive appropriations from the local authorities and the obligatory support of the manufacturers. The schools established during the war at Turin, Milan, Genoa, Modena, Florence, Rome, Naples, and Palermo, will be transformed into laboratory schools. Provision will also be made for the ordinary industrial schools, in all of which short courses of study, both practical and theoretical, will be instituted.

CAMPHOR PRODUCTION IN TAIWAN.

According to information obtained by the United States Commercial Attaché at Tokio, as a result of interviews with officials and selling agents of the Government Monopoly Bureau, and from other sources, the reasons for the decline in the production of camphor in Taiwan in recent years may be summed up as follows:—

There is a shortage of labour to gather the crude material, due partly to the higher wages paid by other industries, especially the sugar industry, and partly to the necessity of going farther and farther into districts which have not yet come under Government control, and are therefore unsafe, in order to get good trees. Labourers prefer to work in safe industries, since the wages they receive in those industries are equal to, or even greater than, the wages paid in this comparatively dangerous occupation. Good trees have become scarce because of the wanton and unorganised cutting down in the past. The companies from which the Monopoly Bureau obtains the raw product

naturally desired to procure the largest quantity of camphor at the smallest expenditure of time and labour. This led to a great deal of waste, only such parts of a tree as gave the largest yield being utilised, while the branches, twigs, and roots were simply neglected.

To systematise the method of gathering the camphor and to prevent waste, these camphor companies have recently amalgamated into one large concern. It should be easy for this combination to compete in the labour market with other industries, as it will be a more simple matter for one company than for three or four to negotiate with the Government regarding the price to be received for crude material, this price being based on cost of production plus a fair profit. It is expected that production will get back to the normal by the beginning of April, 1920. From then on the output is expected to be between 5,000,000 and 6,000,000 kin (kin=1·32 lb.) per annum.

The Government is now engaged in investigations to show the exact amount of camphor which may be expected from all the wild trees in the island, but this survey will not be completed for three or four years. According to a rough estimate, however, the "wild" trees will be available for ten to fifteen years, at the rate of a 5,000,000 kin production per year, after which time the cutting down of the trees, which have been planted by the Taiwan Government, will begin. Although a camphor tree does not reach maturity until it is about sixty years old, it will be necessary at first to cut down trees which are only twenty to twenty-five years old. It is expected that the production will increase as soon as operations on the planted trees commence, before which time all the unsafe districts should be under complete Government control.

The production of camphor during the last four fiscal years (April 1st to March 31st) was as follows:—

	Lb.
1915-16	10,389,521
1916-17	11,506,447
1917-18	7,915,890
1918-19	6,137,732

The Monopoly Bureau sends to Europe what is known as "BB" or "improved" camphor, whereas the United States takes "B" or "crude" camphor. The above figures refer to "B" camphor. In the manufacture of "BB" from "B" camphor there is a loss in weight of 12 to 13 per cent.

OBITUARY.

HENNEN JENNINGS, M.Inst.C.E.—Information has just been received of the death of Mr. Hennen Jennings, which took place on March 5th. He was born at Hawesville, Kentucky, in 1854, and educated at the Lawrence Scientific School, Harvard. After practising as a mining engineer in California (1877-87) and in Venezuela (1887-89), he proceeded to South Africa, where he was consulting engineer to Messrs. H. Ekstein and Co., Johannesburg, and to many Transvaal gold-mining companies, subsequently becoming consulting engineer to Messrs. Wernher, Beit and Co., London (1898-1905). He was also consulting engineer to the Convey Placer Mining Company, Montana, and to the United States Bureau of Mines. In 1903-4 he was President of the Institution of Mining and Metallurgy, London, and he was a member of a large number of engineering and scientific societies in this country, the United States and South Africa. He was elected a Fellow of the Royal Society of Arts in 1901.

NOTES ON BOOKS.

MATHEMATICS FOR ENGINEERS. By W. N. Rose. London: Chapman & Hall.

This work belongs to the Directly Useful Technical Series, and is in two volumes, Parts I. and II., published in 1918 and 1920 respectively. The editor, the late Wilfrid J. Lineham, B.Sc., states in the preface that the books of this series are intended to occupy a midway position between those which are designed to be (1) theoretical, (2) practical. It was the desire to admit the proper amount of scientific explanation, while at the same time omitting matter of purely academic interest. In this endeavour a considerable amount of success has been attained.

Part I. may be stated to be a course of elementary mathematics for engineers, with examples and illustrations largely drawn from engineering practice. It is a graded course, comprising algebra, plane trigonometry, mensuration, and graphs. Chapter VII. is concerned with the practical measurement of irregular areas, such as indicator diagrams, and a good account is given of the practical use of modern forms of the Amsler planimeter and of the application of Simpson's Rule and allied methods. There is no account of the power-driven machines which have superseded the planimeter in the measurement of leather hides, etc. These have been in use for many years in Europe and the United States of America, and some description of the types and the principles upon which they depend, which yield a high degree of accuracy, should find a place somewhere in these two volumes. They may be seen in daily operation in London and other manufacturing towns, and the number of hides measured annually runs into hundreds of thousands. The Leather Measurement Act, passed last year, provides for their official recognition for purposes of trade.

Part II. is devoted to the study of the Differential and Integral Calculus, with the addition of chapters on Spherical Trigonometry and Mathematical Probability. The calculus is treated with special reference to its uses in thermodynamics, strength of materials, applied mechanics, applied electricity, and hydraulics. There are numerous illustrations, and the examples appear to be well

chosen. The chapter on Probabilities will be found useful, but we think more examples might be given, as it is so essential to a practical man to be able to determine the best values that can be obtained from a number of discordant experiments. Too little attention has been usually given to this matter by engineers. The subject is, in reality, as important to them as to astronomers. On page 372 of Vol. II. there is confusion as to the meaning to be assigned to the phrase "linear function of x." $f(x)$ is stated to be a linear function of x in contrast with $f(x^2)$. The oversight should be corrected when a new edition is called for.

The work is well printed, and we have found very few printers' errors. Both for study and reference it is well suited to anyone who is engaged in any branch of engineering.

P. A. M.

Early Bulgarian Art. By Professor Dr. Bogdan D. Filow, Director of the National Museum in Sofia. Berne: Paul Haupt.

One cannot but be struck with the enterprise of the committee of scholars and artists in Sofia who, before their country can have had time to settle down after the devastating effects of the last five years, have been able to produce this handsome volume, printed in English, and illustrated with numerous figures in the text and fifty-eight full-page plates.

The subject is treated historically, and is divided into three main sections: the first kingdom of Bulgaria, the second kingdom of Bulgaria, and the Turkish period. Although, through the ancient Greek colonies scattered along the coast, Greek art penetrated into Bulgaria at an early date, there was a still earlier native art derived from the Thracians. Recent excavations in the burial mounds of Southern Bulgaria have brought to light many specimens of this, which are now to be seen in the National Museum of Sofia; a special characteristic of the period is a love of fantastic representation of animals, and generally the work resembles the Scythian objects of art found in the south of Russia.

It is only natural that in a work of this description one's interest should be centred mainly in the illustrations. These are admirably reproduced, and convey an excellent impression of Bulgarian skill, especially in the carving of wood and stone. The carved wooden doors in the church of Christ in Arbanassi, and the church of St. Nicholas in Ochrida, the marble pulpit in the church of St. Sophia in Ochrida, the door in the mosque of Pazvantoglu in Vidin, the iconostasis in the church of St. Spas in Skoplje—to take but a few, picked out almost at random—are all masterpieces of design and execution. Nor can one overlook the exquisite work in silver, such as the bowl of 1644 in the monastery of Batskovo, and the cross made in Tshipwotzi (17th century). The paintings strike one as primitive and crude in comparison with the high level attained by Bulgaria in the "Arts and Crafts."

GENERAL NOTES.

The King's National Roll.—The first edition of the King's National Roll, a book of over three hundred pages containing the names, address and trade descriptions of patriotic employers who have given undertakings for the employment of disabled men under the National Scheme down to the end of 1919, is now in circulation. The book contains nearly ten thousand names, with full particulars of the scheme, and copies are to be placed at the employment exchanges, in free libraries and other public buildings, with trade unions, employers' federations, and the ex-servicemen's organisations, and in the hands of those whose offers to embrace the scheme have been accepted by the local employment committee of their district. All that the employer has to do is to sign an undertaking that his staff shall include a percentage of disabled men, the percentage being agreed with the local employment committee at the nearest employment exchange. In return the employer has his name placed on the King's National Roll, which is kept for the present at the headquarters of the Ministry of Labour, and is given the right to use a distinctive "seal of honour" on his business stationery. More than one local authority has passed resolutions restricting the giving of contracts to firms who have embraced the scheme, and it may be anticipated that a close scrutiny of the pages will very soon be in progress. Since this book went to press the number of patriotic employers registered has grown to over twelve thousand, and the later additions will appear in new editions of the Roll. The total is still growing, but the supply of disabled men is unhappily by no means exhausted. There are thousands yet to leave hospital; all will have to be found livelihood employment.

Copper in South Timor.—Rich copper deposits have been discovered in South Timor, in the district of Tjamplong. According to the British Consul at Batavia the ore is worth 250 to 400 guilders a ton (£25 to £40 at present exchange), and is reported to be the richest ore in the world. Tjamplong is connected by a motor road with Kolpang, the capital of Dutch Timor, which is about thirty miles away, but a road will have to be constructed from Tjamplong to the mines. It is said that no local labour is available, as the inhabitants of Timor are disinclined even to do the necessary work to cultivate their land.

Power Supply in Victoria.—Boring at Morwell, Victoria, Australia, has revealed within an area of one square mile the existence of between 120,000,000 and 150,000,000 tons of brown coal which can be won by the open cut method. This would be sufficient to provide a 100,000 kilowatt power station with fuel for 150 years. The

Victorian Government, according to the *Engineer*, has decided to erect in the first place a station of 50,000-kilowatt capacity to meet the immediate needs of an adequate supply of electric energy for the Melbourne area. The scheme is sufficient for the needs of the area in 1923, and is regarded as the first step of a greater scheme having for its ultimate objective the linking up of all the available sources of power supply, whether steam or hydro-electric, for the benefit of the entire State.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m. :—

April 14.—Joseph Thorp, "The Fundamental Basis of Good Printing." Sir Herbert Morgan, K.B.E., will preside.

April 21.—Air-Commodore Edward Maitland, C.M.G., D.S.O., A.F.C., "The Commercial Future of Airships."

April 28.—Brigadier-General Charles H. Sherrill, LL.D., "Ancient Stained Glass." The Right Hon. Lord Desborough, K.C.V.O., will preside.

May 5.—Dr. C. E. Kenneth Mees, "A Photographic Research Laboratory." Sir Henry Trueman Wood, Chairman of the Council, will preside.

May 12.—

May 19.—John Somerville Highfield, M.Inst.C.E., M.I.E.E., "Electrical Osmosis." Alan A. Campbell Swinton, F.R.S., will preside.

Indian Section.

Thursday afternoon, at 4.30 p.m. :—

April 15.—Sir Geo. Cunningham Buchanan, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

Thursday afternoon, at 5 p.m. :—

May 20.—Brigadier-General Lord Montagu of Beaulieu, C.S.I., "Roads and Transport in India."

Monday afternoon, at 4.30 p.m. :—

May 31.—Albert Howard, C.I.E., M.A., A.R.C.S., F.L.S., Imperial Economic Botanist to the Government of India, "The Improvement of Crop Production in India." Sir Robert W. Carlyle, K.C.S.I., C.I.E., will preside.

Date to be hereafter announced :—

Sir Valentine Chirol, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

Colonial Section.

Tuesday afternoon, at 4.30 p.m. :—

May 4.—Professor William A. Bone, D.Sc., Ph.D., F.R.S., "Lignite."

Indian and Colonial Sections.

(Joint Meeting.)

Friday afternoon, at 4.30 p.m. :—

June 4.—Professor Sir John Cadman, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E., "The Oil Resources of the British Empire."

Dates to be hereafter announced :—

Graily Hewitt, "Rolls of Honour."

Charles Crowther, "The Arts and Crafts of Japan" (with examples from the author's private collection).

William Cramp, D.Sc., M.I.E.E., "Pneumatic Conveying Plants, with special reference to the Transport of Grain."

Cantor Lectures.

Monday evenings, at 8 p.m. :—

Walter Rosenhain, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

Arthur Thomas Bolton, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.

May 3, 10, 17.

MEETINGS FOR THE ENSUING WEEK.

Monday, March 29...Farmers' Club, at the Surveyors' Institution, 12, Great George-street, S.W., 4 p.m. Mr. W. A. Haviland, "Land Tenure."

Geographical Society, 135, New Bond-street, W., 8.30 p.m. Commander D. G. Hogarth, "War and Discovery in Arabia."

British Architects, Royal Institute of, 9, Conduit-street, W., 8 p.m. Mr. D. Joseph, "Higher Buildings for London."

Tuesday, March 30...Illuminating Engineering Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Mr. J. W. T. Walsh, "Motor-car Headlights in Relation to Traffic Requirements."

Photographic Society, 35, Russell-square, W.C., 7 p.m. Mr. E. W. Harvey-Piper, "Gloucester Cathedral."

Zoological Society, Regent's-park, N.W., 5.30 p.m. 1. Sir Frank Colyer, "Exhibition of Skulls of *Macacus rhesus*." 2. Dr. C. F. Sonntag, "On Abnormalities of the Abdominal Arteries of a Young Panda." 3. Mr. A. Loveridge, "Notes on East African Lizards collected 1915-1919, with Descriptions of a New Genus and Species of Skink, and a New Subspecies of Gecko." 4. Mr. A. M. Altson, "The Life-history and Habits of Two Parasites of the Blowfly."

Wednesday, March 31...Post Office Electrical Engineers, Institution of, at the Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m.

Industrial League and Council, Central Hall, Westminster, S.W., 7.30 p.m. Mr. R. O. Roberts, "Safety First in Industry."

Journal of the Royal Society of Arts.

No. 3,515. VOL. LXVIII.

FRIDAY, APRIL 2, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

PROCEEDINGS OF THE SOCIETY.

COLONIAL SECTION.

A meeting of the Colonial Section was held on Tuesday, March 2nd, 1920; Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc., in the chair.

The Chairman, in introducing Mr. Scott Elliot, said the subject of his paper, which dealt with the whole length and breadth of Africa, was a most fascinating one. It was not so much the result of the war as what had taken place since the war that had made it so evident to the British public that it was more necessary now than it had ever been before in the world's history that Britain should develop to the utmost capacity possible the resources of her over-seas Colonies, in order that she might obtain all the raw material supplies which were so necessary for her well-being. In the consideration of such a complicated problem as that under discussion, it was a great advantage to obtain the opinions of men who had actually been in the Colonies and who had brought back a record of what they had themselves observed. One did not want theorists in such a matter, but men of practical experience, and such a man was Mr. Scott Elliot. Some years ago the Royal Geographical Society awarded the Cuthbert Peek Grant to Mr. Scott Elliot for his exploration of the region to the west of the Victoria Nyanza Lake, and in 1906 he read a paper before the Royal Society of Arts on the commercial prospects of British Central and East Africa. Since then he had seen service in the war. Some little time ago it was hoped that Colonel Steele, who was well known to the Royal Geographical Society, and who had contributed some most important papers to the literature on Africa generally, would be able to attend the present meeting. He, however, very much regretted to say that Colonel Steele had since died at Omsk in the discharge of his duties as a British instructor in artillery.

The paper read was—

TRADE ROUTES FOR THE BRITISH EMPIRE IN AFRICA.

By G. F. Scott Elliot, M.A., B.Sc., F.R.G.S.

At the present moment, that is to say within the next five years, there are opportunities in British Africa which I am afraid are not realised by the general public. Just now we either hold or have a sort of option over nearly a third part of the Continent of Africa, but, unless the chances of to-day are developed with energy and on a carefully planned and designed scheme, it will be the privilege of some other nation to spread commerce, civilisation and Christianity through the most backward of all the continents.

My own experience of the countries concerned is antiquated and perhaps out of date. It is twenty-five years since I trudged the whole weary way from Mombasa to the Victoria. At that time it was a matter of two and a half months to reach Uganda; now it is hardly more than two and a half days. There was then neither railway nor road, except in the very first part of the route. Nairobi did not exist. I do not think there were more than twenty Europeans in the whole of East Africa. Now Nairobi has a population of 15,000, a town council with six hundred municipal rules, five hotels, rickshaws, motor-cars, horses, even a pack of hounds, and the railway system amounts to something like 800 miles.

Though I had my full share of the adventures and alarms incident to travel in those early days, I will only mention that the expedition was a botanical one and that I was collecting plants throughout the whole way from Mombasa to Uganda, on to Ruwenzori, and across Ankole thence by the Kagera Valley, through Urund to the head of Tanganyika.

I had thus a good opportunity of estimating the resources of this wonderful asset of the British Empire, and am thankful to say that there is extremely little of what I ventured to publish at the time that I would like now to withdraw.

The experiences of the last twenty-five years have shown conclusively that there are at least five main climatic divisions in tropical Africa which must be carefully distinguished.

Valleys and alluvial flats as well as all the lower ground up to 3,000 feet altitude make up the first zone. Originally occupied by wet jungle such as that of the Zambesi or the Congo or by the east coast tropical forest, land at this altitude can never be healthy for a European. It is a country for sugar plantations, palm-oil, cocoa, and perhaps rubber and a certain amount of other valuable tropical products. The natives are usually the least interesting and most backward of all Africans, and are also of poor physique.

In country such as this no white man can retain for more than a very short time his normal vigour and energy. Not only are there frequent cyclonic disturbances of his system due to malaria, dysentery, and other tropical ailments, but the regular daily climate is exhausting, and depresses even the strongest natural constitution. Frequent visits to Europe are necessary.

The second zone, between 3,000 and 5,000 feet in altitude, which includes a large part of Nyasaland and Uganda, is entirely different. The climate is not of the same exhausting and debilitating character. Europeans can retain a white man's normal energy for five or ten years, and, as has been proved during the last twenty-five years, conditions generally are probably better than in many parts of India. This zone is characterised especially by cotton, coffee, tobacco, maize, and other important products.

Above 5,000 feet there are large districts which are covered with grass or thin forest; the rainfall is not excessive, and one finds occasionally frost at night; on these plateaux and mountain ridges the climate is to all intents that of Europe; a white man can remain European in vigour for an indefinite time, and white women and children can not only live, but thoroughly enjoy their lives. British East Africa, *e.g.*, contains an enormous area of this sort of country. Sir Harry Johnston's estimate is 10,800 square miles for the eastern section alone.*

* See *Geographical Journal*, January, 1902.

It is a difficult question as to whether these temperate highlands will ever be colonies in the Australian or New Zealand sense. I have heard recently that "nerves" make it impossible to stay more than ten years in Nairobi. Of this I cannot speak, for in the nineties one never heard of this disease. The point is an important one and requires careful research. But whether Europeans can live permanently in the Nairobi highlands or not, manual and heavy labour will always be done by the native African. I do not think any well-informed person would have it otherwise, even if it were possible, which it is not.

The importance to tropical Africa of these temperate highlands can hardly be over-estimated. Each of them is a possible centre, an embryo nucleus for commerce, civilisation, and Christianity, from which development will radiate in every direction.

The Empire in Africa contains, and fortunately, not one but at least four of these temperate highlands; we also have a mandate to develop and control two others, which were formerly in German hands.

There are, of course, other districts which cannot be classed along with the three which I have mentioned above. Much of Africa consists of acacia or scrub forest of a very dry or semi-desert character, such as most of Jubaland, Somaliland, etc. The value of such country is, at present, negligible. Then there are mountain forests such as those on Mlanji, Ruwenzori and Kenia, with a very high rainfall. A certain number of tea plantations will no doubt be possible on the slopes of one or of all these glorious mountains, and there are other possibilities as yet rather undefined.

The distribution of these five varied climates is intricate, but the future of trade depends on their differences being thoroughly understood; otherwise great waste will be inevitable.

But one may say generally that the architectural plan according to which Africa has been designed and constructed gives a very simple guide to the location of, at any rate, the temperate highlands or health centres.

Beginning near Beira in the Pungwe River plains, there is a remarkable trough or Rift Valley, generally some thirty to forty miles or more in width, which runs nearly due north to the head of Lake Nyasa. This belt of country has been let down, so to speak, or has sunk during the contraction of the earth's surface; from which it follows that elevated tracts of land, plateaux, ridges, or mountains, parallel

its course; they are sometimes on the eastern, sometimes on the western, and occasionally on both sides of the Rift Valley.

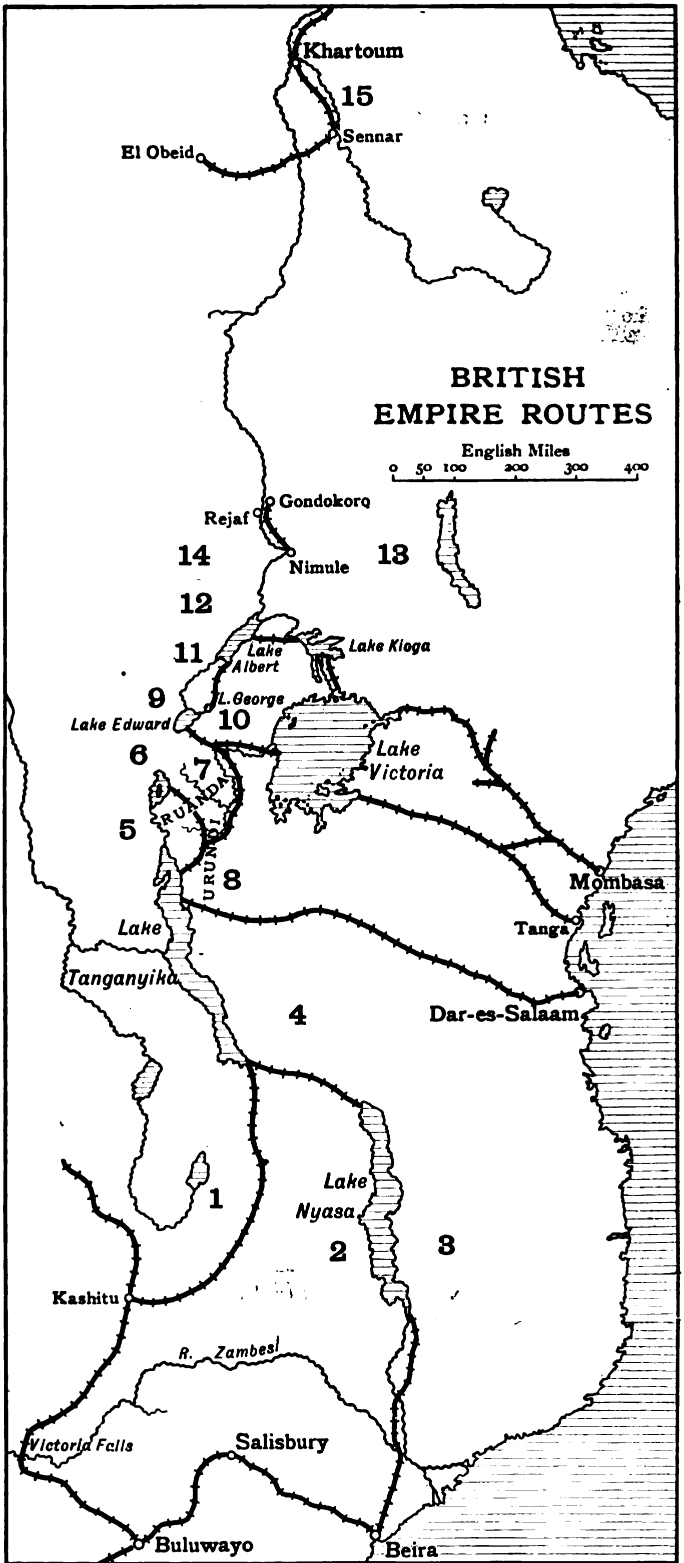
From the head of Lake Nyasa it is continued right up through German East Africa and through British East Africa to Lake Rudolf, and even farther, but I do not want to go into geological details.

A branch Rift Valley, the Central African Rift or Trough, contains the chain of great lakes, Tanganyika, Kivu, Edward and Albert, as well as part of the Nile Valley.

If one remembers this roughly Y-shaped Rift Valley system, the number and positions of the various temperate highlands can be quite easily grasped. They are found to right and left of this gigantic Y-shaped valley or trough.

It is unnecessary to do more than refer to Southern Rhodesia. The eastern edge of the South Rhodesian plateau, which is limited by an abrupt scarp of over 5,000 feet, can be traced for over two hundred miles.

A little further north, if we suppose a rough section taken across the Rift Valley, one finds first the lower ground about Lake Nyasa, which is a most promising cotton, coffee, and tobacco country. It is flanked to the west by the Nyika plateau and the high land about Fort Jameson. After the rather narrow but deep trench of the Luangwa Valley, there is a great healthy highland, the "Plateau" of North-eastern Rhodesia. North-eastern Rhodesia, including Fort Jameson and the Nyika



plateau, form the first (No. 1) of our estates. Here there is probably an area of some 12,000 square miles over 5,000 feet in altitude. Most of it is covered with grass or thin forest. It is extremely healthy and enjoys a European climate, with night frosts in June, July and August. Cattle thrive and are increasing in numbers. Wheat, oats, maize, barley and potatoes do very well. The Awembe, formerly mere land wolves, robbers and raiders, are now becoming usefully industrious.

The "Plateau" is an ideal site for development. Valleys such as the Luangwa, that of the Luapula, and the low ground about Lake Bangweulu are, of course, not included in this highland area. Not only cotton, but rubber, tobacco and coffee have given promising results at these lower altitudes. Sir Frederick Lugard and a very small band of gallant volunteers freed the whole of this region from the tyranny of the Arab slave trader, and the natives are now increasing in number and prosperous.

The lower ground between 3,000 and 5,000 feet about Lake Nyasa forms No. 2 of our undeveloped estates. It is not necessary to give details of its products, for cotton, coffee, tobacco, maize, wheat, ground-nuts and rubber have advanced far beyond the experimental stage.

Hitherto development has been choked and strangled by bad communications. A bale of cotton, *e.g.*, has to be sent by rail from Blantyre to Chindoia; it is then taken by river steamers down the Zambesi at a cost of 82*s*. per ton (Blantyre to Chinde). Here it is again transhipped (for the bar at Chinde has only twelve feet of water at half tide), and goes to Beira (freight 30*s*.). From Beira it is carried to Liverpool at a freight of 115*s*. per ton.

A through railway from Beira to Blantyre and on to Lake Nyasa is an urgent necessity. When the railway has reached (it is to be hoped) Malindi, the whole coast-line of Lake Nyasa (probably 800 miles) will be opened up. A most promising sign is that a large part of the cotton grown now is cultivated by the natives themselves. Probably not one-fifth part of Nyasaland, our estate No. 2, which is 40,000 square miles in extent, has as yet had any chance of developing. Mount Mlanji, with its tea plantations and timber forests differs from the rest of the Protectorate, but has its own possibilities.

On the east of Lake Nyasa, there is in Portuguese and former German territory, a very large area over 5,000 feet in altitude. Some of it, from the descriptions of Stevenson Hamilton and others, certainly consists of healthy grass-covered highlands; this includes the Livingstone range, and other hills forming the watershed.

This estate (No. 3) is quite undeveloped. A large part of it has not even been, so far as I know, prospected. When the railway reaches Lake Nyasa it will begin to go forward. The Trans-Zambesia railway from Beira is already in course of arrangement, and also the necessary continuation to Lake Nyasa.

If this communication to Beira is opened up within the next two or three years, exports and imports should come to Britain. If not, one or other of the competing schemes, either a Portuguese railway to Quilimane or to Mozambique, or the line planned by the former German authorities to connect with the Midland Railway or with the Port of Lindi, will assuredly divert the commerce of these three huge estates to Belgium or Germany.

But you will observe that this Beira railway, though it opens up Lake Nyasa, does not properly serve North-eastern Rhodesia.

Another line is required starting from Kashitu on the Rhodesian system to Kituta and Abercorn. There it should connect with a line from Tanganyika to Lake Nyasa.

The Beira-Nyasa railway is necessary even if it is only to cope with the very promising cotton, coffee, tea, and other possibilities in Nyasaland itself, but it is not by any means enough.

North-eastern Rhodesia, the Stevenson Road plateau, and Kondeland require a direct line of communication with the vast expanding markets of the Transvaal and Rhodesia. I need not spend time on this part of the question, for Mr. H. Wilson-Fox, in the February number of the Royal Geographical Society's *Journal*, shows, on the authority of Lieut.-Colonel Murray, D.S.O., that the construction of a railway from Kashitu north of Broken Hill *viâ* Serenje Mpika to Kasama, Abercorn, and the port of Kitutu on Lake Tanganyika, would be simple and easy. This would be between five and six hundred miles long and place the huge coast-line of Tanganyika within the grasp of British enterprise. Also a connection between Tanganyika and Nyasa, either from Abercorn to Karonga or from Bismarckburg to Mwaya, is clearly an essential matter. This taps the whole of the healthy highlands to the east, and also affords an alternative to the direct route to the port of Beira. I refer you to Mr. Wilson-Fox's paper for details.

Though the Beira line is an essential main line, it is a fact that a large part of it runs

through Portuguese territory, and ends in a foreign port.

Lake Tanganyika is a magnificent waterway, with a coast-line of more than 1,000 miles. Its altitude is variously estimated between 2,740 and 2,759 feet, and it is the second deepest lake in the world, for a sounding of 4,708 feet has been recorded. There are also good harbours. The climate is not at all healthy, but before sleeping sickness ravaged the country, there were large native populations at Karema and three other places along the eastern shore, and coffee, palm-oil, rubber, bananas and other products are grown. To the north at Usumburu begins the rich district of Urundi, which I hope to refer to later.

Along the west side, the country is broken and in places mountainous, but there is on this side continuity with the Congo river system; some suppose that in Jurassic times the sea extended to Lake Tanganyika.

From our point of view, however, the important point is that there are, on the eastern side, two healthy grass-covered plateaux or mountain ridges which can be considered as temperate highlands or health centres. The first (No. 4) lies about 8° latitude, but extends south to our Estate No. 8. I have not been able to get definite information of its extent or altitude, but it is high, well-watered, and grass-covered. It is close to the mission stations of Kirando and Kala, and is also a little north of Bismarckburg.

Further north a similar plateau densely peopled and supporting large herds of cattle is found east and north-east of Kigoma. I do not include this district or the Kitunda mountains, for they are obviously already well served by the direct Kigoma-Dar es Salaam Railway.

As one reaches the northern end of Tanganyika the prospects become more and more promising. On the western side there are grassy highlands 6,000 to 8,000 feet, as well as fine open country at elevations of 5,500 to 9,000 feet to the west of the Rufisi River and Lake Kivu. The grass is short and sweet and the country full of cattle, and apparently well-inhabited. Sir Alfred Sharpe has described this district, and I will call it Sharpe's Highlands.

It is, of course, in Belgian territory, but it should be remembered that it exists when one considers the development of Lake Kivu. We therefore call it No. 5.

On the eastern side of the Rift Valley, before it is interrupted and obliterated by the gigantic transverse ranges of the Mfumbiro volcanoes, are the rich countries of Urundi and Ruanda.

If we take a rough cross-section of the Rift Valley in this latitude, it shows on the west Sir Alfred Sharpe's Highlands, then Lake Kivu itself, lying below 5,000 feet, and on the east again the great green pastures and mountain ridges of Ruanda and Urundi, which rise well over our limit for European settlement.

Lake Kivu itself (No. 6) is said to be the most beautiful lake in Africa. The scenery, following a nice phrase of Grogan's, is a happy blend of Scotland, Japan and the South Sea Islands. There are hills with magnificent pasture and patches of volcanic soil of a very fertile character, but there are also thick tropical forests, barren lava flows and volcanic eruptions are to be expected. Ordinary tropical products should be produced in abundance and without difficulty.

Ruanda (No. 7) and Urundi (No. 8) are admitted by all who have seen them to be perhaps the most promising countries in the whole of Central Africa.

The first has an area of 10,000 square miles and Urundi 11,000 square miles (our northern counties of Northumberland, Cumberland, Westmorland, Lancashire, Durham and the North Riding of Yorkshire amount to about 10,000 square miles).

The population of these two countries is estimated by Dr. Schnee (formerly Governor of German East Africa) as 4,000,000, which is about half the supposed number in the whole enormous area of German East Africa. There are huge herds of cattle. Indeed, all round Lake Kivu Sir Alfred Sharpe estimates 6,000,000 cattle, that is from all these districts, Nos. 5, 6, 7 and 8. The exports from Bukoba were as follows: In 1908, hides and skins weighing 229,000 kg., and valued at 202,000 marks; in 1912, hides and skins weighing 1,119,615 kg., and valued at 1,756,033 marks.

A considerable amount of hides reaches Mombasa from this district even now, so you see that the prospects are extremely promising.

Besides the undoubtedly healthy character of the Ruanda and Urundi highlands, which, as we have observed, are "flowing with milk and honey," the lower ground is extremely fertile. The natives are strong, peaceable, and industrious, and the Wahutu are excellent agriculturists.

I remember even to-day the swarming population and multitudinous banana groves of Urundi near what is now Usumburu. Beans (two or even three crops per annum), peas,

sweet potatoes, earth-nuts, rice and tobacco are grown, as well as millet and other crops.

You will see then, surely, that here there are estates of the greatest value. Such trade as exists finds its way either across the Victoria or to Tanganyika and down the Midland Railway.

Now let us pass along and up the Rift Valley to Lake Edward. The district bordering this lake in British territory (No. 9) is not attractive; but it can hardly be possible that along all the coast-line of a lake of this size there is nothing of value. The salt mines at Katwe have been abandoned to the Congo Free State.

It is otherwise with the grassy and thinly-forested highlands of Ankole (No. 10), which are confidently expected to become the sanatorium of Western Uganda and are surely another health centre for the development of plantations and commerce. With Ankole may be included Rukiga, a wild and rugged land of long, narrow ridges running north-west to south-east, with broad rounded tops and very steep-sided valleys, sometimes narrow and with swift streams, or broad and full of papyrus swamps. The country (after Major Jack) is healthy, and lies at 6,000 to 8,000 feet altitude, and there is no fever.

Passing further north, we arrive at Ruwenzori (No. 11), which is a gigantic upthrust mountain, mostly forest-covered. During my four months' stay in this most interesting of all the countries I have ever seen, it rained almost incessantly. On the lower slopes there are chances for plantations of tea and other tropical products. Ruwenzori resembles Mlanji and Kenia in prospects. It is too soon to say what may or may not be done on these splendid hills, and the discussion of this would be far too elaborate a question to open to-night. At any rate, there will surely be no lack of passengers to the Mountains of the Moon while practical questions are being decided from the results of experiment.

Further north, the Rift Valley is occupied by Lake Albert, which is a beautiful waterway, with a good harbour at Butiaba. A rough section shows on the west, again a splendid health centre, the Balegga Highland, which is a grass-country of a fertile and promising character, and with, close to it, the valuable Kilomoto goldfields and all that can be obtained from the forests and rivers of the Congo (No. 12). A motor road leads from this plateau to the northern end of Lake Albert. The strip of low-lying land on either side of Lake Albert is too narrow to be of much importance.

On the eastern side lies the Protectorate of Uganda, of which the prospects are fairly well known and need not be considered.

But I am tempted to add another estate (No. 13) situated to the east of the Nile, and close to and over the boundary of the Anglo-Egyptian Sudan.

It is the district containing the hills and mountains known as Latuka, Egadang, Dodinga, Kimoto, and perhaps Laroma. Very little is certainly known of these districts, but from the fine descriptions of the late Captain Leeke it seems probable that there are here not only fine forests, but grass plateaux and fertile, well-watered valleys. We will call it Leeke's Mountains. One river falls a sheer thousand feet into the valley of the Kos. The area lies between 32½° to 34° longitude and from 3° 30′ to 4° 30′ N. latitude, but only part of it is high land.

Moreover, on the western side of the Nile, the watershed between its system and that of the Congo is reported as being for a considerable distance fine grassy ridges with a sufficiency of water. This I will call Dr. Christy's Highlands, after the explorer who has specially drawn attention to it (No. 14).

But as regards the actual valley of the Nile (Bahr El Jebel), in what may be called the Sudd region, the prospects are hardly promising so far as trade is concerned.

Sir William Willcocks takes a very hopeful view in his "Egypt Fifty Years Hence": "From Lado to Khartoum will be one unbroken stream about 500 metres in width, of pure and wholesome water, with long rows of willows by the waterside on either bank. The sudd regions and the sudd marshes even, in great part, will have ceased to exist, and in their place will be the beginning of millions of acres of rice-fields and water-nuts."

At present this valley of the Nile north of Lake Albert is unhealthy. Mr. Cana describes the wide unknown region stretching to the border of Abyssinia as "an undulating plain, a swamp in the rains and a thirsty land at other periods of the year. It probably possesses much sylvan richness, and supports a considerable population of unsophisticated negroids."

Nevertheless there are possibilities, for these same people appear to have great herds of cattle, and certainly hitherto they have had no chance to develop.

At the Murchison Falls, which are 140 feet in height, the Nile is contracted to a narrow rock cleft not twenty feet wide; the discharge

is probably constant at about 20,000 cubic feet per second. Surely this is an ideal position for an electric power-station.

There is clear navigation from Lake Albert for 140 miles northward. Then follow some 100 miles of rapids and falls, after which from Gondokoro the fall is only two inches per mile for 1,080 miles northward, and the only obstacle to navigation is the sudd.

In the Ghezira plain (No. 15), between the White and Blue Niles there is the most promising cotton proposition in the world. Some 4,500 square miles (between three and four million acres), are suitable for cotton, and there appear to be good prospects of this enormous area being actually developed provided irrigation can be obtained.

Now, as to the necessary lines of communication for opening up and developing these enormous assets. The Ghezira plain and the whole district of the Bahr El Jebel as far south as Gondokoro is already provided for. The natural outlet is by the Nile and out to Port Sudan, which is said to be a good harbour. But there is a break between Nimule and Rejaf of 100 miles.

British East Africa, the whole coastline of Lake Victoria and of Lake Kioga, are already tapped by the Mombasa-Victoria Railway and its continuation from Jinja on the Victoria to Lake Kioga. This railway must obviously be continued to Butiaba on Lake Albert.

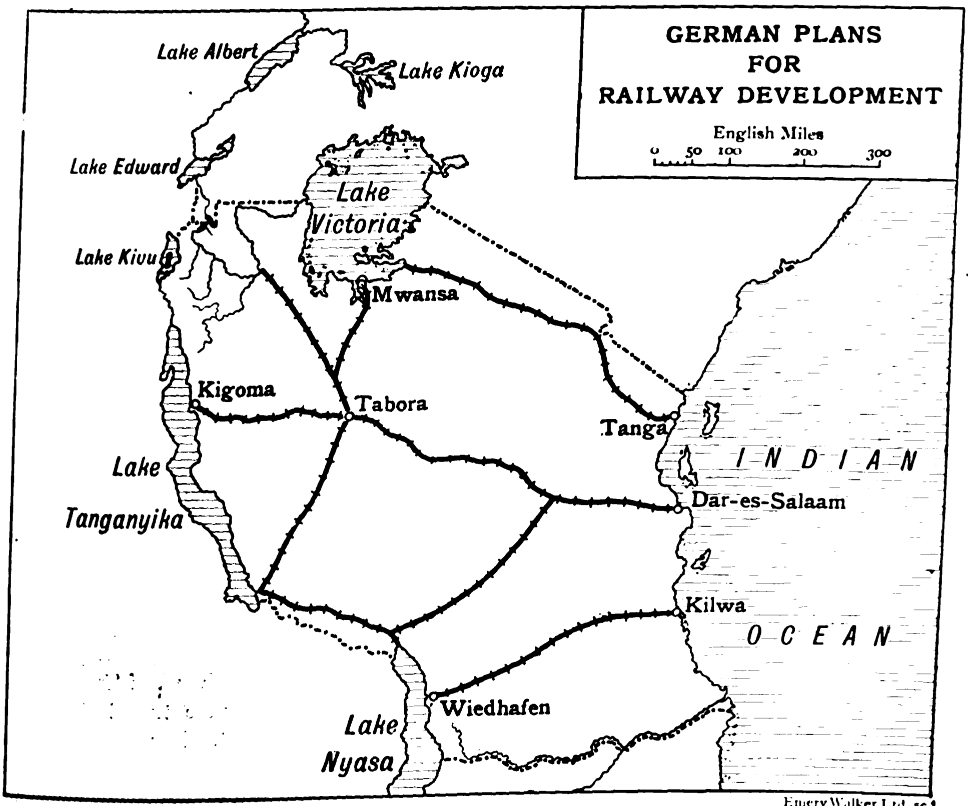
But you will observe that the Murchison Falls, Lake Albert, Lake George, Ruwenzori and Lake Edward, are not provided with any line of communication except roads and tracks.

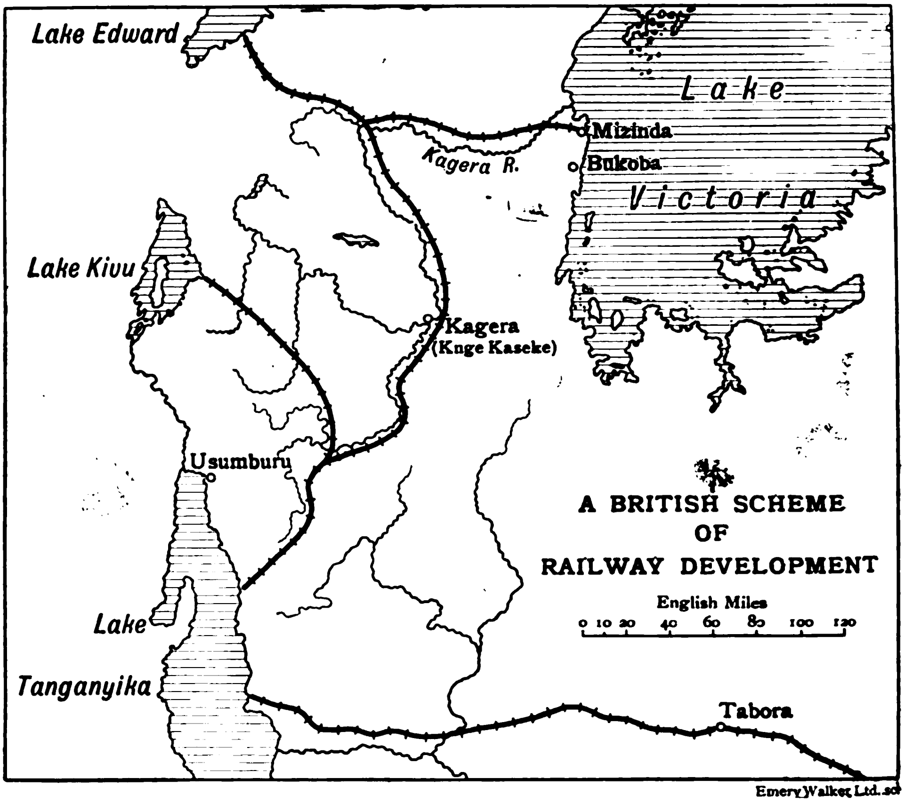
As regards what was formerly German East Africa, the railways actually built and the plans for their extension are well worth close attention.

The Tanga-Kilimanjaro line supplied not only the settlers in the healthy highlands near that mountain, but was most useful in war time.

The Midland to Tanganyika from Dar es Salaam tapped the enormous coast-line of that lake. A branch was to have been built from Tabora to the Kagera Knee near Nyaka-hassa or Kaseke.

This place is a nodal point for future traffic of the very first importance. Starting from Kaseke, which is the Ruvuvu confluence, stern-wheel light-draught steamers could explore the Ruvuvu, which is navigable for twenty-five miles, pass up the Nyaworongo for 200 miles as far as a point within forty miles of Lake Kivu as well as along its tributary the Akenjaru (also navig-





able for sixty-five miles) and along the Kagera itself for 125 miles to the very border of British territory.

Later on, a side line was to go to Muansa on Lake Victoria. From Kilimatinde a branch was to have been built to Lake Nyasa or else a separate railway direct to the sea at Lindi.

Let us consider this system a little closer. All trade from Kivu, Ruanda, and Urundi would be intercepted on its way to the Victoria and carried to Dar es Salaam. So also with any trade from Lake Nyasa, our districts Nos. 3, 4, 5, 6, 7, 8 and 10.

It is true that some, indeed most, of the best German specialists objected to these plans. Thus Dr. Meyer preferred a line from Lake Victoria to the Kagera Knee. Father van der Burght proposed a somewhat different route leading direct to Lake Kivu. Quite a number of German authorities pleaded hard for a railway from Moschi to Aruscha and thence to Lake Victoria.

Commercially those objections were very sound. They were based on a thorough knowledge of the country and its possibilities, but the German Government wished to prevent any traffic reaching the Victoria. Once all the Kivu-Urundi-Ruanda trade had got well into the habit of going to Germany, then they would open the Victoria connection and compete with the Mombasa Railway for the whole trade of that huge inland sea.

As interior lines of communication, and for military purposes, one could hardly wish for a better system.

Had Germany been content to wait in peace and quietness, I have no doubt that nearly one-third of the trade of Africa would have drifted into her hands!

As, however, it is necessary to develop these estates in the interest of Great Britain, the problem is radically different.

For British trade, however friendly our relations may be with other nations, the first necessity surely is that communications should be with British territory and end in a British seaport.

This rules out many of the plans already put forward, *e.g.*, the line already surveyed by the Belgians from the north end of Tanganyika to Lake Kivu and on by the Semliki River to the west of Lake Albert. It also rules out the "Christy" route by the Nile-Congo watershed (see Wilson-Fox). Also, and obviously, the

Tabora-Kagera Knee connection drops out. It was designed by the German Government to destroy British trade with Ruanda and Urundi. It has been most clearly pointed out by Dr. Meyer, Father Van der Burght and others, that this line does not develop Urundi and Ruanda, and is clearly commercially and economically inferior.

What is required is a rail connection between the Victoria and Tanganyika, also between Lake Edward and the Victoria, and such connections should also develop and open up those five vast and promising estates—Sharpe's Highlands, Kivu, Ruanda, Urundi, Lake Edward and Ankole-Rukiga

Now, part of this country has never been, perhaps of design, accurately mapped. One must also and of course admit that a special survey by thoroughly competent railway engineers is necessary before any route can be safely recommended.

Nevertheless, if you consider the wanderings of that vagabond and doubtful-minded river, the Kagera, you will see, I think, that there is a possible route which appears to fulfil all essential requisites.

There is a fair to good possible harbour at Mizinda on Lake Victoria. Thence a railway up the Kagera River would be possible. Colonel Delmé Radcliffe says: "From the mouth of the river to the thirtieth meridian, a road might be traced without any appreciable change of level . . . From the lake shore 3,726 feet above the sea, to Lake Karenge 4,500 feet, the rise is a perfectly gradual one of 775 feet approximately . . . The line could be constructed under the easiest imaginable conditions."*

Moreover, just west of Karenge Lake is the Ruakatenge swamp, practically on the watershed between the Kagera and Lake Edward. If a railway is practicable, therefore, from Lake Karenge along the Kahenji, Chombo or Ntungwe river to the shore of Lake Edward, then half the difficulties disappear. Ankole-Rukiga and Lake Edward, as well as its continuation, Lake George, and Ruwenzori would be in rail or steamer communication with the Victoria and so with Mombasa.

To reach the important nodal point of the Kagera Knee should be a perfectly simple matter; the only difficulty then is to connect this with Tanganyika and Kivu.

Now, German experts state that Father van der Burght knows Urundi and Ruanda better than any other European; the route suggested by him, and no doubt after careful consideration, takes us to Lake Kivu through the very heart of those valuable countries, Ruanda and Urundi.

Should a branch be possible up the Ruvuvu River to Usumbura and Tanganyika, then the whole problem is satisfactorily solved. We have direct lines opening up Lakes George, Edward, Kivu, and Tanganyika to Victoria, and all those valuable estates Nos. 5, 6, 7, 8, 9, 10 and 11 are provided with a chance of direct import and export with Great Britain. I had written this paper before I had seen the February number of the *Geographical Journal*. Captain Phillips's most valuable information published in this paper appears to bear out most of these suggestions.

Many German colonial experts are enthusiastic about a railway line from Moschi to Aruscha and on to the Victoria Nyanza. They did not agree as to the best route and admitted that much of the country traversed was waterless and uninhabited. Moschi is, however, now connected with the Mombasa Railway. No doubt a short and strategically useful line might be constructed to the southern end of the Victoria; in times of peace also a competitive route to Tanga would no doubt relieve the Mombasa-Victoria line, which has even now more traffic than it can carry.

But any line to the Victoria should be well within British territory, and not on the other side of the frontier.

There is, however, no connection between Lake George and Lake Albert. There can hardly be very much difficulty, except a large number of bridges, in constructing a line from Lake George towards or near Fort Portal, but from this place there is a very steep descent to the shores of Lake Albert. The Wasa River may, however, afford a possible route.

Should these connections be made we have a real Cape to Cairo line in the sense in which it was understood by Cecil Rhodes.

With regard to this sound business proposition, which has been libelled as a "phrase" or "ideal," I venture to suggest that the insight and genius of Cecil Rhodes have been amply justified by the results of the last few years.

Had the Cape to Cairo line been built when he first suggested it, there would never have been a German East Africa in a military sense.

Had it been in existence in 1914, thousands of lives, not to speak of many millions of money, would have been spared, for Von Luttow

* "It is protected against eastern and south-eastern gales."—G. J. Delmé Radcliffe, December, 1905.

Vorbeck could not possibly have maintained himself for so long a period.

Indeed, I venture to suggest that the extra millions wasted through the protracted resistance in East Africa would have built the railway ten times over.

Rhodes, moreover, was a man of business. He realised, and I am sorry to say his critics did not then and do not now understand, that it is only in British territory that our exports have fair play and only from British ports that raw materials have a chance of coming to our shores.

He also foresaw (and Rhodesia has abundantly justified him) that starting from the great ever-expanding markets of the Transvaal, the true line into Africa is by the Rift Valley, or rather along the healthy highlands bordering it.

The expansion of Rhodesia surely proves that his view was correct.

By the scheme outlined there are some half-dozen areas as promising or even more promising than British East Africa used to be some twenty-five years ago.

The failure to carry through Cecil Rhodes's "ideal" at the time when it was suggested appears to me to have delayed the development of Africa for a quarter of a century.

Against the scheme to-day, I find usually the same arguments that were used then.

First, the "breaking of bulk" at every change from rail to steamer; I have been informed that breaking-bulk used to cost about 2½d. per ton in the Sudan.

Secondly, that lateral railways should be built by the quickest possible route to a seaport. Those who allowed the Cape to Cairo line to be side-tracked on account of this argument should have seen these east–west lines carried through at once, specially that to Nyasa, which is not even finished to-day.

This objection, however, falls to the ground in any case, for the system here suggested provides direct access to all the African lakes as well as the essential and necessary north-to-south line.

The cost of these railways will, of course, be very considerable.

The following table gives the approximate cost per mile of various African railways. Most of it is taken from German sources (Baltzer, *loc. cit.*), and it must only be considered as approximate, that is, as a rough guide as to what may be expected.

RAILWAY TABLE.

Length. Miles.	Nationality.	Name.	Passenger kilometres (millions).	Tons. Kilometres.	Cost per mile.	Excess Receipts over Expenditure.
					£	£
26	German	Togo Coast			2,124	
	German	South-West Africa (lowest)			3,000	
75	German	Togo Inland			4,085	
102	German	Togo Hinterland			4,108	
223	British	Sierra Leone			4,320	22,000
113	French	Ivory Coast	3·8	2	5,069	
	French	Dakar St. Louis	32	22·5	5,400	90,160
90	British	Magadi			5,914	
2,500	British	South Africa Company			6,000	
368	French	Konakry Karussa	8·6	6	6,195	92,000
346	French	Upper Senegal	6·6	8	6,300	
	French	Guinea			6,437	60,000
273	German	Tanga Aruscha	13·6	3·2	6,630	11,000
782	German	Midland Tanganyika	22·3	6·5	7,966	75,000
	German	South-West Africa (Upper Limit)			8,000	
100	German	Kameruns (North)			8,046	
300	German	*Estimate* Tabora-Kageraknee			8,368	
76	British	Lagos Ibadan			8,595	
114	British	Nyasaland, Port Herald to Blantyre			8,771	
618	British	Uganda Railway			10,513	209,000
171	British	Gold Coast, Sekondi			10,943	165,000
261	Belgian	Congo	7		13,200	
176	German	Kamerun Midland			13,711	

Herr Baltzer (Die Kolonial-Bahnen, Berlin. 1916) states that the shareholders of the Matadi Leopoldville Railway, in the Belgian Congo, received a dividend of 19 per cent. The Otavi Railway in 1912 gave a return of 9·95 per cent. I think, in 1911, the Nigerian Railway gave a return of over 4 per cent on the capital expended.

The data (except Uganda Railway) refer to the years 1910 to 1912. The net earnings of the Shiré Railway were £281 per mile in 1917

and £292 in 1918. Marks were reckoned at twenty and francs at twenty-five to the pound sterling.

This system, which will open up practically one-third of the Continent of Africa to British trade, may be taken as follows :—

		Miles.	
Southern Section	1. Kashitu—Kasama—Kituta—Abercorn	600	800
	2. Abercorn—Karongas	200	
	3. Luchenza—Malindi (Nyasaland)	(133)	
	4. Trans-Zambesia	(165)	
Central Section	1. Tanganyika to Kaseke	100	541
	2. Kaseke to Kivu	137	
	3. Kaseke to Kakitumbo	100	
	4. Lake Karenge—Lake Edward	60	
	5. Lake Karenge—Kagera Mouth or Mizinda	144	
Northern Section	1. Lake George *viâ* Fort Portal—Lake Albert	75	275
	2. Lake Kioga—Butiaba	100	
	3. Nimule—Rejaf	100	
	Or leaving out Southern Section, Nos. 3 and 4, a total of	1,616	

A special survey would, of course, be necessary before any one of them can be recommended. Mr. Wilson-Fox estimates for the Southern Section £6,000 a mile. One might take for the Central Section, say, £7,500 a mile, and for the Northern Section, say, £7,500 for No. 1 and 2, and £6,000 for No. 3.

During my service in the Egyptian Campaign I had frequent opportunities of observing the manner in which the Egyptian Labour Corps made a railway seem actually to grow before one's eyes. If it were possible to use Egyptian labour for the third line of the Northern Section I believe the cost would be far less even than £6,000 per mile. Their methods were practically those employed by their forefathers at the construction of the great Pyramid, but the rapidity and efficiency of the work done was beyond all praise.

The only lines on which there might be such difficulties as were encountered on the Uganda Railway are Central Section No. 1 and Northern Section No. 2.

The total capital required would then appear to be somewhere about £10,170,000, to which £1,000,000 for repairs to the Uganda line must be added.

As to the prospects of dividends, I have already given a few details of the railway earnings in various parts of Africa.

These show that there is hardly one of these railway lines that is not either already a paying affair or may be with reasonable probability soon expected to become remunerative.

Or, one may take it from another point of view, by considering the total imports and exports and their rate of growth.

From the general point of view, prospects are surely promising enough.

The Central Section in particular will open up a huge district with a population nearly as large as that of Scotland, and with a considerable trade already established.

The Northern Section has one known and valuable goldfield, and will assuredly open a further large cotton field. North (No. 3) is the only line of which at present the commercial prospects are a little obscure (see below).

		Imports. £	Exports. £	Total. £	White population.
British East Africa	1913–14	2,148,000	1,483,000	3,631,000	
„ with Uganda	1917–18	2,810,000	1,742,000	4,552,000	6,132
Nyasaland	1913–14	189,000	201,000	390,000	
	1917–18	354,000	157,000	511,000	731
Rhodesia South	1918	2,957,000	5,254,000	8,211,000	30,000
„ North	1917	356,000	343,000	699,000	2,165
German East Africa	1913	2,668,000	1,778,000	4,445,000	5,336

There are two or three special and particular prospects which should be mentioned.

Large supplies are required by the many missionary stations, and no doubt such stations will increase in number as well as in influence with the railways.

The tourist traffic by a real British Cape to Cairo route will surely be considerable. Ruwenzori and Mfumbiro are much more interesting as a tourist resort than modern Switzerland.

Then, also, a through route by rail and steamer would bring pilgrims direct to Jerusalem and Constantinople as well as to Medina, *en route* for Mecca.

There are many Mohammedans in Central Africa, and a large number will certainly undertake the Mecca pilgrimage when it can

be properly arranged. It is not possible at present.

In addition, there is the Government traffic, which is sure to be considerable. I regard those four sources, missionary, tourist, pilgrim, and Government traffic, as affording an immediate revenue, so that from the purely dividend-earning point of view the prospects are sound. But that is not by any means all that there is in it.

To the British working-man these railways are of immediate and vital importance. Our trade in cotton, and its manufactures, means at least £100,000,000 a year. I need hardly enlarge on the danger in which this great industry lies. It is up to us to produce somewhere in the Empire all the cotton we require. The production of America is annually less, and annually more and more swallowed up by increasing manufacture in the United States. The British Cotton Growing Association are making splendid efforts to drive this point home to the comprehension of the working-man, and I need not enlarge on it. Without criticising Government in the past (which I have studiously avoided) I venture to put a question which requires explanation :—

Seeing the importance of encouraging cotton cultivation, why did the Uganda authorities impose an export tax of £1 per bale on cotton?

Here in these railways to Nyasa, and from Victoria to Tanganyika, Albert and Kivu lies the present opportunity for Britain.

Almost as important is the question of oil seeds and feeding-stuffs. The prices of feeding-stuffs are at present enormous. It is to this, in large part, that is due the high price of eggs, of bacon, of milk, butter, and cheese. Ground-nut cake, *e.g.*, costs the British farmer £24 10*s*. per ton, cotton-seed cake £27 10*s*., and bean meal £27 per ton.

In all these new districts there is a practically limitless field for beans and peas, ground-nuts, gingelly or beniseed, for maize, as well as for rice, wheat, and oats. I am only mentioning a few of the more important products in which, as a practical farmer, on a very small scale, I am deeply interested.

The other side of this question is just as important. The whole of these countries form an ever-expanding market for manufactured articles of every sort. Cotton cloth is in most parts of Africa the chief article of import, but it is in the thousand-and-one articles of European make that the opportunity for the British manufacturer is at present open.

It seems to me that there will be the severest possible competition for this hardly tapped and practically inexhaustible market during the next few years. Japan, Germany, Belgium, and other countries are alive to the possibilities of Africa.

I have never been able to understand why the British working-man takes no apparent interest in this question of African development, for his existence as such in Britain depends upon it.

As regards the native himself, the more Africa falls to the guidance and control of the British, the better off he becomes. If European control were removed, then there would be *at once and within one generation* an immediate relapse to the horrors of the slave trade and the devilish cruelties of the native chiefs. When our officers first visited the Awembe country, many people, some mere children, were found with ears, lips, noses and hands cut off.

The population of the Anglo-Egyptian Sudan dwindled from 8,000,000 to 1,800,000 through massacre and famine during the occupation of the Dervishes.

Under British control, the natives in Africa are increasing in number; they are becoming more prosperous and learning the salutary lessons of civilisation.

In a British Capetown to Cairo line we have perhaps the most splendid opportunity that has ever been placed before any nation on the face of the earth. All along it there are fine healthy ridges and plateaux. There missions can be established, and from them Christianity can permeate and penetrate the whole of Africa; a string of bright stars will shine out along the entire length of the Dark Continent.

From the point of view of security and strategy alone, a Cape to Cairo line of communication is an absolute necessity; surely the bitter experiences of the last few years have abundantly proved this. Abyssinia lies to the east and north of it, and the Sudan and Uganda must be in the closest possible touch.

Although everybody must admire the enterprise and courage displayed by the Government in establishing an air route along the Cape to Cairo line, I feel that while these stations will be strategically of infinite importance, they are hardly yet of great commercial value. If every aëroplane requires four mechanics, and petrol has to be supplied in quantity, it is clear these stations will involve a very large extra traffic.

If, as appears from the most recent announcement of Government intentions, Ruanda and

Urundi are to be handed over to Belgium, and if the Congo Free State or Belgium is to have an *enclave* at the Port of Dar es Salaam, then the construction of these railways is even more urgently necessary. Otherwise, all the trade from this port, inwards and outwards, will go to Belgium, or more probably to Germany.

It is really impossible to quote all who have written on this question, but I wish specially to mention Sir Alfred Sharpe, Sir Harry Johnston, Sir Charles Metcalfe, Mr. MacCarthy, Mr. H. Wilson-Fox, Colonel Delmé Radcliffe, the late Colonel E. A. Steel, Major Grogan, Major Bright, Major Cuthbert Christy, and the late Captain Leeke, to whose works I am greatly indebted. I have also to thank the Royal Geographical Society for the loan of maps and lantern-slides.

DISCUSSION.

The Chairman (Sir Thomas H. Holdich), in opening the discussion, said that the author was to be congratulated on having read a very useful and interesting paper. He had not wandered into any flights of fancy with regard to the aeroplane, as he might have done, because he was as convinced as he (the Chairman) was, that it would be many a long year before aeroplanes could be brought into any kind of competition with railway traffic for commercial business. Those present would have observed from the paper that there had lately been a good deal of controversy on the subject of railways in Africa, particularly at the Geographical Society. Mr. Wilson-Fox had recently made a rather startling proposal about a railway from Beira to Cairo, his idea being that the communications between those places should be connected by rail-ferries on the lakes, and in that way a great deal of railway construction would be avoided. For practical reasons, however, that idea did not find very much favour. He thought one could not do better than accept the author's division of the country into three districts, the south, the centre, and the north, and confine one's attention generally to what was wanted in each. Anyone, by looking at the map, could see at once that railway problems in the south-east were very far forward. There had for many years been one gap between Beira and the Zambesi, but that was rapidly being filled in. In the south-west, however, there was no communication between the Transvaal and the western coast, and he had often been surprised that no such communication had yet, so far as he knew, been suggested. He thought use might be made of Walfisch Bay for a much closer and more direct communication with Pretoria. On the north one was faced with the everlasting choice between a direct line following the Nile Valley and the detour, which had already been commenced to a certain extent, from Khartoum to Obeid and Fasher, then turning southward and leading up to the Nile-Congo watershed, which the author had called "Christy's Highlands." That would cover a very large amount of country which appeared to be particularly suitable for railway construction, not only on account of the physical character of the country, but from the character of the inhabitants. If that plan was carried out, he could not help thinking that the railway forecasted by Dr. Christy, through Belgian territory along the Congo from Stanleyville to the head of the Northern Rhodesia Railway, would be the first opening of a direct line from the Cape to Cairo. Although he personally had no acquaintance with any of that part of Africa, he had had the opportunity, from the highlands of Abyssinia, of looking over the stretch of broken hills and lowlands which flanked Abyssinia on the west and formed the western revetment of the Abyssinian plateau. From the very limited view he had of it, it certainly appeared to be most unpromising country, and he could not believe, on account of the enormous amount of bridging that would be necessary, that it would ever be possible to bring a line from the Cape to Uganda to the east of the Nile. With regard to Central Africa, the author's third division, that was the crux of the whole position and the kernel of everything connected with future developments in Africa. He had formed no opinion at first hand with regard to the matter, but he thought that the railway connection through all that part of the country contained so many isolated plateaux and highlands entirely favourable for European occupation that it was inevitable that eventually the general line of communication would not be either north to Cairo or south to the Cape or Beira, but to the east, and that the outlet for the central trade would be found on the east—it was to be hoped as soon as possible, because if the outlet was found on the west it would be simply putting the trade into the hands of the Belgians. Although he had not had the opportunity of working professionally in Africa, he had worked in very rough country on the north-west frontiers of India with a view to railway developments, and, so far as he knew, in every case where a railway survey had been made purely for the purpose of alignment, without waiting for a general geographical map of the whole district to be made and put into the hands of the engineers before they commenced the work, a line had been chosen which would not have been chosen if a geographical map had been available at the time. Such a map, which was quite large enough if made on the scale of four miles to the inch, should be made before anyone became obsessed with the idea that any one particular line was the only line to follow; otherwise the engineers engaged in the work could not tell what physical difficulties they might have to encounter, or what the prospects of traffic would be on alternative routes. There was no such map of Central Africa at the present time, but he hoped it might soon be obtainable.

SIR ALFRED SHARPE, K.C.M.G., C.B., said the author had spoken of the Cape to Cairo railway. He thought possibly he might have had him in mind, as he had expressed opinions at one time and another regarding this project. He had never wished to depreciate for a moment the value of a railway through from the Mediterranean to Cape Town; from a strategic point of view alone it would be of enormous value. What he had always said, however, was that the magnificent countries lying along what might be called the backbone of Africa required first of all outlets to the nearest ports on the sea coast. He had not the slightest doubt that the Cape to Cairo through route would eventuate of itself in a very short time, by the inter-connection of the present railways one with another and with the great lakes. The author had shown where the natural trade outlets would be—Beira for practically all Rhodesia, Nyasaland and Zambesia; Dar es Salaam for the Tanganyika territory; and Mombasa for Uganda, British East Africa, and no doubt a considerable extent of the eastern part of the Belgian Congo. He would like the author to say whether his scheme and all the other schemes being put forward at present were based on the idea that this country was ever going to give German East Africa back to Germany. He had never contemplated before that Germany's African territories would be returned to her. If they were, then our railway schemes in Africa would have to be arranged so that we could bring all the trade to our own ports; if not we could simply bring it to the most convenient ports. The paper had been one of the very greatest interest, and was the most lucid description of the conditions governing the development of Central African territories to which he had ever listened.

ADMIRAL THE HON. SIR EDMUND FREMANTLE, G.C.B., said he would not attempt to go into the geographical or commercial details with which the author and the Chairman had dealt, but wished to strike a personal note. He had the pleasure of meeting the author about thirty-two years ago in Madagascar, where, if he recollected aright, Mr. Scott Elliot was practically marooned through an outbreak of smallpox, and he took him, in the flag ship, from there to Zanzibar, from which place he was able to conduct further investigations into the subject on which he was then engaged. That was to a certain extent a proof of the great length of time during which the author had been studying Africa and his competence as an African observer. Another proof of that was to be found in the exceedingly able and interesting paper that had been read that afternoon.

MAJOR E. H. M. LEGGETT, R.E., D.S.O., in moving a vote of thanks to Mr. Scott Elliot for his very illuminating paper, said he was sure the large number of people throughout the world who would read the paper when published in the Society's *Journal* would feel their indebtedness to the author as much as did those present at the meeting. He had undoubtedly made an important contribution to the great Imperial problem of communications throughout Africa, in which country England was fortunately pre-eminent. He would not attempt to follow the author into his magnificent visualisation of the future or to discuss with him the many routes which he knew Mr. Scott Elliot himself would be the first to admit were open to discussion, but there was an aspect which overshadowed all the pros and cons of this or that proposition, and that was the intense Imperial need for the development of Africa. Its potentialities as a producer of raw material and as a consumer of British-made goods must be developed, and, as the author had said, Africa was a country in whose future the British working-man had a stake which could hardly be overestimated. The author had laid stress on the point that there must be no links missing in the chain of communications. The first great link was that of the ocean—the ocean was the Imperial line of communication with all the world. Then, as this country commanded the ocean, it must consider how it could get from the ocean on to the mainland, and that was a point he hoped the author would deal with on a future occasion—the harbours. Harbours were essential in the Empire trade routes, and needed the attention not only of thinkers and travellers but of statesmen and business men. It was easy to waste large sums of money in squeezing through a bottle-neck harbour, and the trade, both import and export, which spent those large sums hardly knew why it was suffering from such a tax as was imposed by anything that was not fully efficient in the working of the harbours, which gave the access from the sea to the land. Another point which the author might deal with in a future paper was the question of whether the existing railway lines were capable of carrying the traffic which was now developing so rapidly. It was obvious that the extension of railway lines was so necessary that the great strategy of railway development throughout Africa should be taken in hand, but he would suggest that in the conduct of all affairs both strategy and tactics were required. Strategy without good tactics might fail, and the tactics of traffic were the efficient conduct of the minor details. He therefore suggested that the existing lines needed a very thorough inspection and overhaul, and a calculation as to whether they were equal to the traffic of the next two or three years. The events that occurred during the next two or three years in the great African territories would have a bearing on the financial success and even on the prospect of obtaining the strategic lines of communication of the future, because it was existing lines which gave confidence to capital and to Governments by the earning power which they showed. Their earning power had hardly yet begun to be developed, and with comparatively small outlays the earning power of the existing lines could be quadrupled, or multiplied to an even greater extent than that. After the five years of war, during which they had

necessarily passed through a period of deterioration, without the opportunity of being kept up to their pre-war standard, the railways of Africa now had to cope with a far greater traffic than before the war; and he suggested they should be thoroughly overhauled, and that in discussions such as the present one, where the great future before Africa was dealt with, no one should forget or gloss over, or allow those who controlled money or Governments to forget, that the existing lines must be kept up to date and even ahead of the traffic they were at present carrying.

MAJOR H. BLAKE TAYLOR, in seconding the resolution, said that, as a former General Manager of the Uganda Railway, he could endorse the remarks Major Leggett had made as to the very great necessity of keeping the railways up to the full carrying capacity to meet the rapid development of the country. Many parts of East Africa and Uganda were developing trade far beyond that which the railways were now fit to carry, and that applied also to Africa generally. He agreed with Sir Alfred Sharpe that traffic would go to the nearest port, and any attempt to divert to Mombasa traffic the natural outlet of which was at Dar es Salaam would absolutely fail—it would not be economic. He also agreed with Sir Alfred that Germany's African colonies should not be returned to her.

The vote of thanks was carried unanimously.

MR. SCOTT ELLIOT, in reply, said he was not afraid that German East Africa would be given back to Germany, but what he was afraid of, was that the trade of German East Africa would go back to Germany. That was the important point. With regard to trade outlets, it would be found that the railway scheme he had drawn up gave the shortest route to the coast, although it did not go to Dar es Salaam. It provided quite as short a route from Central Africa to the coast by going to Mombasa as it would if it went to Dar es Salaam.

The meeting then terminated.

GENERAL NOTES.

STAINED GLASS AT THE VICTORIA AND ALBERT MUSEUM.—The Victoria and Albert Museum has lately received two important loans of stained glass. The first, lent by Mr. William Burrell, comprises five panels of French sixteenth-century work that were at one time in the collection at Costessey Hall, Norfolk. Two of these are from a "Tree of Jesse" window of the early part of the century. The remaining three, representing scenes from the life of St. John the Evangelist, with figures of the donor and his family kneeling below, may be assigned to the year 1530 or thereabouts. They are all five thoroughly characteristic examples of late French Gothic glass, showing great skill in the balance and harmonising of the colours. The second loan, from Mr. George Eumorfopoulos, consists of two specimens of English work of the fifteenth century. One, a panel representing St. George, and formerly in the collection of the late Mr. Lewis F. Day, belongs to the first quarter of the century. The other, a roundel of the Annunciation, and formerly at Ditton Park, Bucks, is slightly later in date, and was probably made about 1450. It is a charming piece of work and thoroughly English in character.

CAROLENE GAS.—A new gas, to take the place of acetylene in blow-pipe work, has been produced in America. It is called carolene, and, according to the *Engineer*, is said to have a thermal value of 1,580 British thermal units per cubic foot. The composition is 84 per cent. carbon and 14 per cent. hydrogen, and as the gas can be safely stored in unpacked cylinders at a pressure of 3,500 lb. per square inch, a considerable saving in weight can be effected. The maximum temperature obtainable is put at 6,200° F.

RAILWAY ELECTRIFICATION IN ITALY.—According to *La Tribuna*, the work of the Commission for the electrification of the railways, appointed by the Minister of Transports, is proceeding actively. The Railways General Management are continuing the electrification, on the three-phase system, of the line between Turin and Genoa of about 400 kilometres, and by means of a private undertaking the lines Turin-Milan and Milan-Voghera for another 200 kilometres, in order to complete as soon as possible the principal links of this system. With regard to central Italy, a meeting was held recently, under the presidency of the Minister of Transports, between the various public bodies and companies interested in the utilisation of the electric power in the Umbro-Tuscan-Emilian district, in order to co-ordinate available power for local requirements and railways. The Commission approved plans for two thermo-electric stations at Tavernelle di Perugia and Torre del Lago, capable of producing about 20,000 kilowatts per hour. Plans have been started for linking up Rome and Naples with the southern provinces. A programme has also been drawn up for the extension of steam traction by oil fuel for those lines where it will take some time to provide hydro- and thermo-electric power, that it is to say, largely in Sicily, Calabria, Basilicata and Puglia.

PALM SUGAR IN BRAZIL.—In common with many other palms, writes the United States Consul at Rio de Janeiro, *Nipah fructificans* contains sugar in quantity sufficient to make its extraction a commercial success. It is estimated that at least 12 per cent. of sugar could be recovered from the sap, and that an average annual yield of 4,000 gallons of sap per acre would yield 4,000 lb. of sugar. This palm is found in great numbers in Borneo. In Brazil, in the Amazon basin, the Indians prepare for their feasts and

pow-wows a beverage from the sap of a great number of palms, but it is not known to what species these palms belong, or if any experiments were made to determine their sugar content. Rubber cutters and travellers agree that "palm wine" is very refreshing as long as too strong a fermentation has not set in.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m. :—

April 14.—Joseph Thorp, "The Fundamental Basis of Good Printing." Sir Herbert Morgan, K.B.E., will preside.

April 21.—Air-Commodore Edward Maitland, C.M.G., D.S.O., A.F.C., "The Commercial Future of Airships."

April 28.—Brigadier-General Charles H. Sherrill, LL.D., "Ancient Stained Glass." The Right Hon. Lord Desborough, K.C.V.O., will preside.

May 5.—Dr. C. E. Kenneth Mees, "A Photographic Research Laboratory." Sir Henry Trueman Wood, Chairman of the Council, will preside.

May 12. — Graily Hewitt, "Rolls of Honour."

May 19. — John Somerville Highfield, M.Inst.C.E., M.I.E.E., "Electrical Osmosis." Alan A. Campbell Swinton, F.R.S., will preside.

Indian Section.

Thursday afternoon, at 4.30 p.m. :—

April 15.—Sir Geo. Cunningham Buchanan, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development." The Right Hon. E. S. Montagu, M.P., Secretary of State for India, will preside.

Thursday afternoon, at 5 p.m. :—

May 20.—Brigadier-General Lord Montagu of Beaulieu, C.S.I., "Roads and Transport in India."

Monday afternoon, at 4.30 p.m. :—

May 31. — Albert Howard, C.I.E., M.A., A.R.C.S., F.L.S., Imperial Economic Botanist to the Government of India, "The Improvement of Crop Production in India." Sir Robert W. Carlyle, K.C.S.I., C.I.E., will preside.

Date to be hereafter announced :—

Sir Valentine Chirol, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

Colonial Section.

Friday afternoon, at 4.30 p.m. :—

May 28.—Professor William A. Bone, D.Sc., Ph.D., F.R.S., "Lignite."

Indian and Colonial Sections.

(Joint Meeting.)

Friday afternoon, at 4.30 p.m. :—

June 4. — Professor Sir John Cadman, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E., "The Oil Resources of the British Empire."

Cantor Lectures.

Monday evenings, at 8 p.m. :—

Walter Rosenhain, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." Three Lectures.

April 12, 19, 26.

Arthur Thomas Bolton, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.

May 3, 10, 17.

MEETINGS FOR THE ENSUING WEEK.

Wednesday, April 7...Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m.

United Service Institution, Whitehall, S.W., 3 p.m. Lieutenant W. S. King-Hall, "Submarines and Future Naval Warfare."

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Dr. A. V. Peatling, "Mediæval Glass in Surrey Churches."

Sanitary Engineers, Institute of, 296, Vauxhall Bridge-road, S.W., 8 p.m. Captain A. F. Girvan, "Modern Development in Civil and Military Water Supply."

Thursday, April 8...Camera Club, 17, John-street, Adelphi, W.C., 8.30 p.m.

Historical Society, 22, Russell-square, W.C., 5 p.m. Miss M. Dormer Harris, "Unpublished Documents relating to Town Life in Coventry."

Friday, April 9...London Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 4.30 p.m. Miss Amelia Defries, "Art and the City."

Cyclist's Touring Club, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Annual General Meeting.

Astronomical Society, Burlington House, 5 p.m.

Auctioneers and Estate Agents' Institute, 34, Russell-square, W.C., 7.45 p.m. Sir H. Trustram Eve, "Village Reconstruction."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 6 p.m. Mr. T. J. Clark, "The Uses of Concrete."

Correction.—In a General Note on "Flax Culture in Russia" in the *Journal* of March 19th, 1920, page 298, col. 2, the following sentence occurred: "The average yield to the acre for Russia was only 300 tons as against 400 to 700 tons to the acre for other countries." For the word "tons" in each case the word "pounds" should be substituted.

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FRIDAY, APRIL 9, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

NEXT WEEK.

MONDAY, APRIL 12th, at 8 p.m. (Cantor Lecture.) WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." (Lecture I.)

WEDNESDAY, APRIL 14th, at 4.30 p.m. (Ordinary Meeting.) JOSEPH THORP, "The Fundamental Basis of Good Printing." SIR HERBERT MORGAN, K.B.E., will preside.

THURSDAY, APRIL 15th, at 4.30 p.m. (Indian Section.) SIR GEORGE CUNNINGHAM BUCHANAN, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development." THE RIGHT HON. E. S. MONTAGU, M.P., Secretary of State for India, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

PROCEEDINGS OF THE SOCIETY.

TWELFTH ORDINARY MEETING.

WEDNESDAY, MARCH 3rd; BRIGADIER-GENERAL SIR PERCY SYKES, K.C.I.E., C.B., C.M.G., in the chair.

THE CHAIRMAN, in opening the meeting, said he had never had the privilege of visiting Mongolia, but some years ago, when he was Consul-General in Chinese Turkestan, he was told that Mongolia was in his district and he was very anxious to go and see it. He found, however, that the capital of Mongolia was just 2,000 miles from where he was living, and as one could only travel at the rate of about a hundred miles a week it would take him twenty weeks to do the journey, so he did not go. Mr. Garnett, who was to read the paper that afternoon, had enjoyed exceptional opportunities of studying Mongolia. He had travelled in the country for seven months and had the additional advantage of being in touch with the authorities, so that he was able to learn a great deal more about the country than an ordinary traveller could possibly do.

The paper read was—

MONGOLIA FROM THE COMMERCIAL POINT OF VIEW.

By WILLIAM JAMES GARNETT,
First Secretary, H.B.M. Diplomatic Service.

To estimate correctly the value of any country from the point of view of commerce it is essential first to understand the customs, mode of life, geographical features and administration of that country; and it is with those objects in view that I have constructed this paper this afternoon. There is no time to give any historical account of the people who inhabit that vast region known as Mongolia, although such a history embraces as long a period and as wide an extent of the world as that of Rome herself, and has had as profound an effect on the destinies of the human race, including the European nations. My knowledge of the country is derived from a seven months' journey made in 1908—mostly on camelback—and, though it may be thought out of date to-day, let me say that were the great Genghiz and Kublai to arise from their graves to-day they would find their country and their countrymen much as they left them. The circumstances prevailing, therefore, in Mongolia at present are substantially the same as prevailed in 1908.

Upon the overthrow of the Mongol Empire in China by the Ming dynasty in 1368, the tables were turned, and Mongolia was invaded and conquered by China, the Mongols were pushed back to their original home in the Kerulon and Orkhon valleys and never again appeared in any strength south of the Gobi, except to establish themselves in the Ordos. The energetic

Chinese of North Shansi and Chihli gradually pushed back those few Mongols who did take advantage of the weakness of the Ming dynasty to establish a footing south of the Gobi, and gradually absorbed the fertile plains right up to the foot of the plateau. They also crossed the Gobi and established trading centres in North Mongolia, at Urga, Uliassutai and Kobdo, and solitary Chinese traders may also be found at occasional Mongol camps along the tracks across the deserts. Early in the present century the Chinese Government appear to have desired to extend this colonisation process, and instructed their representatives to "open up" their land to Chinese colonists. The Governor of Uliassutai informed me that there was no land suitable for farms in his province. This was, however, quite incorrect, for there are a quantity of well-watered districts in that province which could support a large population, and where wheat, kaoliang, millet, etc., could be grown. An official was also sent to the Altaishau to construct the new colony of Sharasumé.

The Russian Government demanded the maintenance of the *status quo*, the first effect of which was that the North Mongol princes fell increasingly under Russian influence, the second effect being that these princes asked for independence from China. This led to the Kiakhta Convention, which did not mean that Mongolia was fit to govern herself, but that Russia "*drang nach Osten*" was temporarily irresistible. With the complete collapse of the Russian Empire the situation was bound to revert to that which existed before the Kiakhta Convention, and that is what has occurred.

Kalgan is, as you know, the main south gate to Mongolia; but there is another town, Kweihuacheng, farther west which will rival it when railway, road, river, and postal facilities are forthcoming, for Kweihuacheng, in addition to its favourable geographical situation between Mongolia and Shansi and Shensi, also taps the fertile Yellow River strip on the left bank of that stream from Ninghsia, very little use being made yet of the Hoangho for transport of goods from that last-named place. There are several ferries across the Hoangho, and we crossed by flat barges to the south-west of Kweihuacheng, continued south-west through the Ordos as far as the Great Wall, and, turning north-west, crossed the stream again close to Ninghsia. The Ordos district is most unattractive; it is an inhospitable sand-swept country, lying in a loop formed by the Yellow River and bounded on the south by the Great Wall; it consists of rocky ravines and sandy plains, with a few secluded fertile valleys; there is a great deal of drift sand; for pasturage there is a certain amount of thorny scrub and thin grass. The entire district is useless for colonisation, and there are practically no Chinese to be found, though a few are engaged in extracting salt from the numerous lakes of varying size. The seven Mongol princes who rule the district have no importance. Should, however, a venturesome traveller cross their difficult stretch of land (by camel, for there are no roads) he will receive a warm welcome from the Roman Catholic missionaries at Borobalgasson and Hsiao-chiaow-pan.

Ninghsiafu lies in a most remarkably well-cultivated area. From the very banks of the Hoangho the ground is covered with thick grass and carpeted with flowers. There are groves of trees and villages at every turn. The whole aspect of this bank of the Hoangho is in marked distinction from that which we had left, which was brown, sandy, bleak, desolate, treeless; and there is no reason why Ninghsia should not become a centre for Mongol trade, for it is only two days by camel across the Alashan Mountains to Dinyuaning, the capital of the Mongol kingdom of Alashan. From Dinyuaning a track runs across the desert to Uliassutai, through one of the most difficult parts of the Gobi, it is true, yet one which is used by Europeans, for at Dinyuaning I met Colonel Kozloff, the Russian explorer, who had just crossed by this route.

Alashan, though nominally Mongol, has fallen much under the influence of Peking, through a succession of Manchu consorts for the Alashan sovereigns. There was therefore a prosperous Chinese trading colony, and their intercourse with the Mongols has had a civilising effect on the latter. I noticed many cheap Japanese goods at Dinyuaning, and the room of the son of the reigning sovereign was littered with cheap clocks, watches, gaudy tablecloths, rugs, pictures and mirrors.

Returning to Kweihuacheng, partly along the fertile Yellow River strip and partly across the north portion of the desolate Ordos, we prepared to cross the Gobi to Urga.

I understand that nowadays the Gobi can be crossed, from Kalgan at any rate, by motor-car in four to six days; but no such convenience existed in 1908, and we made use of the Tai-lu or official track across the desert, changing our camels for fresh ones every twelve miles or so at a Mongol camp where Government has

stationed animals for the purpose. Although one thus always finds Mongol tents at which to sleep, it is necessary to carry tents (and even water) for a journey in the Ordos or in other parts of Mongolia than the Gobi. At these camps there is always a well (there is no surface water in the Gobi until the Khangai Mountains are reached) and the inevitable mutton to eat.

There is an impression that the Gobi is a sandy desert. That impression is wholly incorrect, for between Kweihuacheng and Urga one does not come across a single stretch of sand. On the contrary, the ground is entirely covered with a thin short grass, which forms abundant pasturage for the tribes. But a camel journey across this part of the Gobi is inexpressibly dreary. You can travel for fifteen days without seeing a single tree, nor any cultivation, nor bird life, nor, except at the midday halt to change animals and again at nightfall does one see any Mongol encampment. The surface of the ground is flat or at the most only slightly undulating, and the gravel track can, as a rule, be seen for miles ahead. Nor does one meet any other travellers, except very occasionally a mob of thousands of sheep or ponies going to market in China.

The journey from the Kweihuacheng plain on to the plateau of Mongolia can be made by cart, and it is interesting to note the quantity of beans, wheat, wool, etc., coming down, and to what extent the Chinese have cultivated the fringe of the plateau. There has, however, been no extension of this colonisation since 1872, for the same Chinese settlements noted in that year by Ney Elias, namely, Kokoillikung and Sanyuyuan, still remain the advance guard of Chinese progress in this direction.

And so we reached Saire Ussu (gravelly water) where the tracks to Urga and Uliassutai fork, and two days later were in hilly country again, hilly, yes, but still treeless until the wooded heights of the Bogdo Ula, south of Urga, come in sight.

Just before reaching Urga the River Tola has to be forded, and as this was in full flood a week later on account of heavy rains, a small cart bought at Urga was entirely submerged. I am therefore curious to learn how the Kalgan-Urga motor services manage this last lap into Urga.

Urga is the largest of the North Mongolian settlements, and is the only one which appeared to be at all thriving in 1908. The plain was full of yourts (the felt-covered Mongol tent), there were great quantities of sheep, goats, etc., everywhere, and Mongol horsemen and horsewomen were galloping about in every direction. The many temples seemed to be much more cared for here than elsewhere. Trade is carried on with Kiakhta, a distance of 165 miles.

As regards the sort of goods sold in these Chinese settlements in North Mongolia, I made a brief list of them in 1908, and I imagine such a list holds good to-day: Russian goods of all kinds (especially household utensils), silks, Chinese and Mongol boots and shoes, Chinese hats and caps, Chinese robes, snuff-bottles (a very necessary article of daily use in Mongolia, as the exchange of snuff-bottle is the Mongol form of salutation), cotton cloth, instruments for temple use, sheepskins, chop-sticks and cheap Japanese goods, especially looking-glasses, towels, beads and chains, photos of Japanese singing girls, knives, scent, soap, snuff, tobacco (Chinese *not* foreign), Mongol kettles, rugs of gaudy colours. The amount of cheap gaudy Japanese articles struck me in 1908 as enormous, and they attracted both Chinese and Mongol alike. Raisins, dried apricots, eggs, flour, rice, millet, salt and vegetables were the chief foodstuffs on sale—all brought from China, the stock being renewed regularly by caravan.

The products of Mongolia are wool, hair, skins and animals (especially sheep and ponies), and these are bartered for the ordinary commodities of life. There was in 1908 no metal currency, the chief item of barter being the teabrick; in one district I found long strips of coloured rags used for barter. Both Chinese cash and lump silver are taken in the settlements, but much of the silver which comes in is used by the women for personal adornment, or by the men for ornamenting their saddles. Russian money was also used in Urga, but I understand that it has given way now to the Chinese dollar. I will refrain from saying anything about the activities of the Chinese or Russo-Chinese banks, as I have no up-to date information on the subject. I imagine, however, that the Mongol nature has not changed, and that he is still a happy-go-lucky spendthrift, ready to throw away his property in exchange for anything which glitters or which takes his momentary fancy. He will thus always be in debt to someone. The Chinese traders established at certain camps in the desert act also as money-lenders and, in default of payment, frequently receive some of the debtor's cattle, which is then convoyed to China and sold at a considerable profit to the trader. I have seen this adversely commented upon in certain modern books of travel. I cannot understand why; it seems a perfectly fair businesslike transaction.

From Urga we retraced our steps to Saire Ussu, and turned north-west to Uliassutai, a month's journey by camel, and crossed the Onghin, Tatz, Tui, Ut, Baiderik and Djak streams, all of which flow from the Khangai to be lost in the desert. The valleys are full of rich grass, on which thousands of beasts feed. Well watered and sheltered, these valleys support only a small population as yet, and would make excellent farm land. At this stage the weather is worth mentioning, for we had been delayed at Urga by the excessive rains, and these had pursued us as far as Saire Ussu. Nothing is done, however, for the conservation of the rainfall, nor of the waters of the above-quoted streams with a view to irrigate the districts.

After climbing out of the Djak valley we crossed the ridge which parts the waters of these streams from those which flow northwards to the lakes in North-West Mongolia, and descended into the valley of the Chobolgol, a headwater of the Jabkon. Thence we proceeded into the valley of the Buyuntugol, and at Hochertu camp came across the first Russian trader residing in the desert. This is an indication of the extent to which Russians had penetrated into the country—not that it appeared to be to the detriment of the Mongols, for the Russians brought plenty of goods to barter for the wool, etc., and one of the features of the district was the number of well-to-do Mongols riding about in long crimson cloaks. One traveller writes of the "red-coated" Mongols, but this was the first instance I met of Mongols wearing red coats, nor did I notice any similarly clad outside the Uliassutai district.

On reaching Uliassutai we crossed the Bogdingol by the Green Dragon bridge.

The town has many points of comparison with Urga, the chief being the abundance of water (which, however, is bad for drinking on account of the wool-washing done in the stream) and the all-pervading squalor. It consists of a number of houses—of wood or of mud or of both—with large yards attached to them, each being surrounded by a high palisade of poles. The streets and lanes thus have a singularly uninteresting character, and after rains they become long pools. In the only important street the Chinese and Russian shops were to be found side by side, for the time had passed when, according to Ney Elias, the Russian traders were herded together in a joss house outside the town. But there was a forlorn appearance about the street which testified to the absolute stagnation of trade. The Russian traders numbered seven or eight (as Ney Elias records three in 1872 the increase has not been rapid), and shared in the general depression. A few Chinese merchants were engaged in the wool trade, but this and the hair trade were practically monopolised by the Russian traders who had erected sheds for cleaning and drying these commodities in all the neighbouring valleys as well as in that of the Bogdingol.

The life of Uliassutai was thus gradually being squeezed from the Chinese. Ney Elias's description of Uliassutai in 1872 holds good to this day, and the settlers have still made no further attempt at cultivation than that of cabbages and turnips for local consumption, while, as nothing has been done to reafforestate the hills, the supply of wood, which in 1872 was "scanty and hard to find," must to-day be scantier still.

As at Urga, so at Uliassutai there was a Russian Consul. There was none at Kobdo nor Sharasumé.

The journey from Uliassutai to Kobdo took us eight days. In a country such as Mongolia where landmarks are scarce, it may be interesting to note that three miles before reaching Kobdo there is an Obo or cairn of special sanctity.

Ney Elias noted in 1872 the scarcity of wood in this district also, and this scarcity is so great to-day that small brushwood has to be brought from a very considerable distance for the needs of the settlement. There has been no change in the appearance of the colony during all these years. There are the usual two mud-built towns, the official so-called fortress, and the open trading quarter; but the streets of the latter are wide and clean—quite unlike those of Urga or Uliassutai—and rows of fine trees grow on either side of the main thoroughfare.

Unlike Urga and Uliassutai, Kobdo is rich in vegetables—potatoes, beans, carrots, turnips, melons and cucumbers being grown plentifully. Nearly every house had its own small garden, and each was well watered by a small irrigation canal from the river.

Preparations had now to be made for crossing the Altaishan to Sharasumé, and the Amban kindly detailed an officer off to escort me thither. He also furnished a special passport in Mongol and Hassack. Our movements were slightly hampered by a convoy of German guns which were being forwarded to Sharasumé.

We left Kobdo by the Suok road (Suok is the frontier station at which commerce enters and leaves Mongolia in this region), but two days later turned westwards over the

mountains. I will not weary you with a detailed geographical description of the country we now traversed. We were always climbing passes to drop into depressions containing lakes of varying size and fording icy-cold streams, for it was the first week in September and the passage over the Altais is closed by snow from September to April, the scanty population migrating for this period to the foot of the western side of the range. At Daunnoor we reached a narrow belt of fir and then crossed the bleak main chain of the Altais by the Ermektudaba pass and were in the headwaters of the Kran (or Kilingho), itself a headwater of the mighty Irtish. Dropping rapidly through blinding snow and in bitter cold, we entered another zone of thick fir forest, followed by woods of willow, birch and poplar, with a dense mass of low scrub, and wound our way down the western face of the Altais to Sharasumé, and to summer again.

Sharasumé, Altaishan or Chenghwassu, is the new colony to which I have already referred. In 1908 there were only ten Chinese shops, all branches of Peking and Tientsin establishments. They sold articles of clothing, snuff-bottles, and the necessaries of life, renewing stock three times a year *viâ* Guchen by camel caravan. The entire population of the settlement was not more than 1,200, of whom 1,000 were "soldiers." The traders found existence difficult. The Amban, a most enlightened and cultivated official, of whom I still have the kindliest recollections, complained bitterly that there was no telegraph, and he had asked for permission to connect his colony with Manas by telegraph; every matter had to be sent to Chuguchak by horseman to be telegraphed to Peking. Chuguchak is a month to the west by camel caravan. He spoke of the necessity, too, of linking up the colony with the nearest Russian frontier station, Zaisansky Post, whence are brought light bamboo furniture, muslin curtains, window glass, and other amenities of life at Sharasumé. He said there was an abundance of coal and gold in the mountains and that he knew where they were. He added that the object of his Government was to establish order where chaos had reigned supreme, to civilise the Mongols and Turkis (he had just issued an order that the Mongols must bury their dead instead of throwing them out to the dogs in the desert), and to exploit the mineral wealth. There is also an abundance of ginseng in the district.

I will not trouble you with an account of the remainder of the journey to Buluntogoi, thence to Chuguchak past the Tourgout prince's fixed residence, and on to Kuldja, beyond to note that Buluntogoi is merely a geographical expression and is not a large settlement such as the maps appear to indicate; that the Tourgout prince is the descendant of that Mongol tribe which, emulating the migration of the Israelites from Egypt, quitted the Volga *en masse* in 1771 for their present district (of 70,000 families only a portion survived the journey), and that Chuguchak is a busy commercial place close to the Russian frontier and its trade is chiefly with Russia, as is also that of Kuldja, the approach to which, over the Borokhoro range, by the picturesque but narrow Talki Gorge, is blocked by deep snow in winter, as I found to my suffering in October 1908.

And there I will stop, merely adding that unless and until rapid means of communication across the desert exist the trend of the trade of the north districts must inevitably be towards Siberia. It will be a long time before the Mongols are consumers to any extent. They lack everything, it is true, but their needs are few and still primitive. The resources of what is called Mongolia are, however, an unknown quantity, and the country, especially in the north could bear a much larger population and more stock could be raised. The problem is, who will develop it, for the Mongols themselves are incapable of doing so, who will tap the mineral resources, construct irrigation works, and restore Mongolia to that wealthy condition which she seems to have enjoyed in the days of the great Khans.

In view, however, of the ties which have knit China and Mongolia for so many centuries, and of the necessity for filling a political vacuum caused on this frontier of the late Russian Empire (as on others, *e.g.* Persia), there can be, to my mind, no doubt as to the desirability of China resuming that position from which she was ousted by unworthy intrigues. Whether she will be able to retain it will depend on how she tackles the above-mentioned problems.

DISCUSSION.

MR. JOHN BADDELEY said he had not been in Mongolia himself but had only touched the borders of it, so that he could not criticise the paper from any local knowledge. Sometimes, however, a traveller failed to look about him to any great distance on either side, and in any case there were certain points he would like to mention lest those among the audience who had not made a special study of Mongolia and Mongolian history should carry away with them, possibly, some very

erroneous impressions. In the first place in regard to the statement that there was no sand in the Gobi he would point out that while "Gobi" was a Mongol word meaning "desert" the Chinese term for the Gobi was *Shamo*, meaning "sand-desert"; and on various maps, including that of Mr. Ney Elias—one of our greatest Asian travellers and only not more famous because of his own excessive modesty—the word "Gobi" was written right across from the Takla-Makan, or at least from Lob-nor to the Great Khingan, a stretch of from thirty to forty degrees of longitude. Now, if we accepted that as correct we should find that the Gobi contained thousands upon thousands of square miles of sand. On the other hand it was true that on the route followed by the author between Kalgan and Urga there was very little sand. The second point he wished to mention was that the description given in the paper referred to one section of the Mongols only, that is, to the Khalkhas or Northern Mongols, who constituted perhaps a fourth or even a fifth of the whole race. According to the last edition of the *Encyclopædia Britannica* the population of Mongolia was about 5,000,000. But he would take, preferably, the most recent available Russian statistics, those, namely, of 1914, which put the population at between 2,500,000 and 3,000,000 only. Of these the Khalkhas accounted for some 700,000; nearly all the rest dwelt south of the Gobi, the vast majority constituting the celebrated forty-nine banners of the Inner Mongols, whose territories extended along the Great Wall from the Liao River to the Hoang-ho. A traveller proceeding from Kalgan to Urga might see very little of them, for they are all nomads; but they none the less existed and must be taken into account. Besides the Northern Mongols known to the author and these banner-men of Inner Mongolia, there were the Western Mongols or Kalmuks, and this brought him to his third point. As mentioned by the author, the Mongols were turned out of China in 1368 by the Mings, but the author seemed to think that they had played no great historical part after that down to the present day. Now this was not the case. To take but one salient episode in each century. In 1449 a Kalmuk chief, Esen, ruled outside the Great Wall from one end to the other—a distance of some 1,200 miles. Next year, 1459, the Ming Emperor of China, *In-tsong*, came out from Kalgan and fought a battle with Esen, who defeated and took him prisoner. In the sixteenth century the Kalmuks fell back into the second rank, but we find the Eastern Mongols under Altan or Yenta, the powerful chief of the Tumeds, whose capital was the author's *Kwei-hwa-cheng*, not only attacking China in force and raiding whole provinces year after year, but actually besieging Peking. The Portuguese adventurer, Ferdinand Mendez Pinto, whose name the English dramatist Congreve used as a synonym of liar, but who, like most travellers, sometimes told the truth, relates how, as a prisoner of the "Tartars," he was present at this siege in the year 1544, and both siege and date are fully confirmed by the Chinese annals. In the seventeenth century the Manchus appeared on the scene, but before they could take China they had to make terms with, or get rid of, the Mongols. Accordingly they made friends with some, fought and conquered others, and in 1664 took Peking. But even then the Eastern and Northern Mongols were powerful enough to require very careful watching. Finally, early in the eighteenth century, the Kalmuks reached the climax of their power. They had driven their hated kinsmen, the Khalkhas, into final submission to China. They had taken Tashkent and Turkestan (town) from the Kirghiz-Kazaks; they had conquered Chinese Turkestan with all its cities from Yarkand and Kashgar to Turfan and even Hami; they received tribute from the remote Mussulman Saricolis close on the Hindu Kush; and in 1717 they invaded Tibet, stormed Lhassa, and, for a brief period, ruled it. They fought Kang-hi, Yung-chen and Kien-lung, and it was only in 1757 that the latter, after twenty years' strife, finally vanquished and practically annihilated the royal race of the Kalmuks, known as the Sungars or Eleuts. In conclusion, Mr. Baddeley paid a tribute to the paper as one of much interest and extremely well illustrated. He had listened to it with great pleasure.

Mr. Byron Brenan, C.M.G., said that, unlike the author, he had never had the advantage of travelling in Mongolia, but when he was living in North China parts of Mongolia occasionally came to see him. Sometimes on a very fine day in the winter a yellow cloud would be seen on the horizon; then in a short time a breeze would arise which turned into a howling gale, and for three days the air would be thick with dust from the Gobi Desert. At the end of that time the houses and gardens would be covered with at least one-eighth of an inch of Mongolia. In that way, therefore, he had had some acquaintance with the country. Another means of knowing something about Mongolia was that every winter caravans of Mongols came down to trade in Peking, and shortly before the new year strings of camels laden with goods of all kinds, principally frozen food of various descriptions, came down to Peking, and the goods were sold to the people in exchange for ornaments. He did not think that if at any time the Mongols were left to themselves there would be very much chance of trade development. They were easily satisfied, had very few wants and were not at all enterprising. One had only to go back about seven hundred years to the days of Genghiz Khan to see how very much the people had deteriorated. There were opportunities in Mongolia for adventurous people, and those who went there would probably be the Chinese, for wherever there was a chance of carrying on trade, there the Chinese would go. At the present time the great difficulty was finance—the Chinese would bring up goods to sell to the Mongols, and the Mongols would have nothing to give in exchange. The only thing to do was to make contracts far ahead

for cattle, sheep, ponies, and especially wool, but the wool, of course, could only be furnished at a certain time of the year. To give an instance of the difficulties of exchange, he might mention that a good many years ago a very fine Russian circus was coming across to China, and as it had to go through Mongolia its enterprising manager thought he would partly pay his way by giving entertainments in that country. The only kind of currency with which the people could pay for their seats was the dried dung of the camel, and the day after the performance the manager sold the whole heap or exchanged it for something a little more manageable, and repeated the operation at the next stage. The great need of the country was transport facilities, everything being carried by means of camels. At present the railway went from Peking through mountain passes to a place called Kalgan, and he thought it now reached as far as Kweihuacheng. It was intended to carry it on as far as Kiakhta and to connect it with the Trans-Siberian Railway, but the late war, the revolution in China, and all the recent trouble in Russia, had put a stop to those developments. As an instance of what traders suffered from want of transport facilities, he might mention that one of the principal products of Mongolia, wool, was brought to the port of Tientsin, near Peking, and was sent to America to be made up into coarse cloth or carpets. That wool was brought on camel-back a journey of perhaps thirty or forty days, and on the way down the men in charge of the camels would steal some of it, and, having given a receipt for a certain weight, they kept that weight up by sprinkling water over the wool and then scattering sand all over it, with the result that when the wool was passed through cleaning machines in Tientsin, about ten or twenty per cent. of the weight was found to be composed of sand from the desert, on which freight had been paid at the rate of something like £5 a ton to bring it to Tientsin and which necessitated further expense in the cleaning process before the wool could be packed. A good deal could be done to improve the articles which were used as barter in carrying on trade. Many years ago a rich Chinese merchant retired on his fortune to a farm near Peking, and he imported fruit trees, the best grain, and also good cattle. Amongst the animals he brought to his farm were some very fine merino rams which he obtained from California, and finding that his farm did not suit them he sent them into Mongolia. The wool from Mongolia was sent to America and landed at San Francisco, where the American Customs House authorities imposed a duty according to the grade of the wool, which they divided into three classes—the very coarse, the medium, and the best. After the merino rams had been in Mongolia about three years, the Customs House authorities at San Francisco wrote to the American Consul in Tientsin asking him to make inquiries as to why it was that the wool was so very much better than it had been before and stating that it had been transferred from the low to the medium grade. That was entirely due to the few rams that had been sent to Mongolia. The Mongols themselves could not be expected to do that kind of thing, and certainly the Chinese would not, because they were not going to pay £500 for a good ram to be sent to Mongolia for the benefit of the world at large. The Chinese Government could do it, but it was the very last thing it would think of doing. No one could tell what the future of Mongolia was going to be. When it was like a no-man's-land between Russia and China the policy of Russia was to prevent its becoming strong or populated by Chinese, because Russia wanted it as a buffer State and perhaps looked forward to taking it for herself in the distant future. The Chinese encouraged their people to settle in the country as a buffer against Russian aggression. Both Russia and China were *hors de combat* at the present moment, so it was difficult to say what would happen to Mongolia. If there was an opening for trade there the Japanese would not miss the opportunity; they were very strong in Manchuria, which adjoined Mongolia, and they could live in a way in which Europeans could not, as far as expense was concerned, and would discover openings where nobody else would think it possible to embark in trade.

The Chairman (Brigadier-General Sir Percy Sykes, K.C.I.E., C.B., C.M.G.), in proposing a vote of thanks to the author for his interesting paper, said that Mongolia appealed to some people a great deal as the land of Prester John. It was mentioned by the monks Carpini and Rubruquis and also by the great traveller Marco Polo, and, as the author had said, there seemed to have been very little change in the country since that time. The author had not said much about the yaks. His own experience of them was that they were very unpleasant animals, and had a strong dislike for Europeans in the parts of the world where he had ridden them. They had a very curious habit of grunting like pigs, and that is why they were called the "grunting ox." Mr. Baddeley had mentioned the value of the work done by the late Mr. Ney Elias, and personally he thought that explorer's work was becoming more and more appreciated. He agreed with Mr. Baddeley that Mr. Ney Elias had suffered very much through his own modesty, as he could never be persuaded to talk about what he had done. One reference of very great interest made by the author was to the Tourgouts, who were expelled at the beginning of the eighteenth century by the Zungars and journeyed an enormous distance to the Volga. About sixty or seventy years later they found that the Russians were beginning to get a grip on them so they decided to trek back again. That journey had been immortalised by De Quincey in his book, "The Revolt of the Tartars." Another point of interest mentioned by the author was that of communications. Nothing had been more burned into him during his thirty years in the East than the

value of communications. Without modern means of transport there could be no progress. Mines, for instance, that would pay with modern means of transport had not the slightest chance of paying if everything had to be carried on camels. When the Chinese wanted to go from China to Kashgar, in Chinese Turkestan, they went almost round the world in order to obtain good means of communication. First they went by sea round by Singapore and Ceylon and up to Aden, and then to Constantinople, Batum, and Baku. Then they travelled up the Central Asian Railway to Andijan and went by carriage to Osh, whence it was a twelve days' journey to Kashgar. They said it was not only three times as quick to go by that route instead of across land from China to Kashgar, but the cost was only about a quarter as much. The time occupied by the land route would be at least six or eight months. He did not quite agree with the author about the wealth of Mongolia in former days, because he thought that wealth was largely artificial. As the author said, the Mongols ruled as far as the Dnieper, and Matthew Paris mentioned in his chronicles that, in 1238, the Swedish fishermen dared not come to Yarmouth for the herring fishery on account of their fear of the Mongols. At any rate up till the war, prayers were said in the churches in Galicia and other parts of Eastern Europe for deliverance from the Mongols. That showed that the Mongols had an enormous empire. They took everything they could from the countries they conquered and then had to keep on sending presents back to headquarters at Mongolia, but the Mongols did not develop their country in consequence of that. They had probably become very lazy and ceased to be wealth producers, and so when the tide turned and the Mongols went under again, they very soon lost all the wealth that had been poured into their country during the period when they were practically masters of the known world. The geographical formation of Western Europe was probably what prevented the Mongols from completely overwhelming the very weak civilisation that then existed there, and that in turn was mainly owing to the rainfall of Western Europe, which made the stony valleys that were so unlike the country the Mongols were accustomed to, and that was so unsuitable for cavalry. He did not agree with the author that the tent was preferable to the Mongol yourt; personally he much preferred the latter, especially in cold and windy weather. He would like to ask the author what was the name of the trees at Kobdo—an avenue of which had been shown in one of the slides. The question of reafforestation was one that affected rainless countries enormously. Grazing, especially of goats, in most parts of Asia prevented any trees growing, and reafforestation was only possible in countries where there was a strong organised Government, such as in India, where the Government had enclosed huge areas round Quetta and was gradually reafforesting them. He would also like to ask the author whether he obtained any sport in Mongolia.

The Author, in replying to the discussion, said he ought to have made it clear that his paper did not deal with the whole of Mongolia, but only with that part through which he had travelled. He could assure the Chairman that in the valley of the Yellow River from Ninghsiafu to Kweihuacheng and just across the Ordos one could obtain the most magnificent pheasant shooting in the world; every bit of shrub and bush all along the valley contained one or two birds. In the Ordos there was also the antelope, and in the northern part of Mongolia, especially in the valley of the Jabkon, between Kobdo and Uliassutai, there were duck and geese, and, he had been informed, wild swans. With reference to the remarks made by Mr. Brenan about the probable influx of Japanese traders into Mongolia, he thought that was a question that required very careful attention, because where trade went the flag might also follow, and if Mongolia was flooded with Japanese trade political influence might succeed the commercial influence. He regretted that he did not know the name of the trees at Kobdo which he had shown on the slide. He agreed with the Chairman that the Mongols never had been wealth-producers. According to ancient historians they were very well-to-do people, but he agreed that their wealth came from outside the country and might be described as loot. When their power dwindled and they lost their political influence, they naturally lost their jewels and other forms of wealth that they had, and sank into a position of poverty, in which they still remain. With regard to the yourt, he agreed with the Chairman that it might be the most comfortable form of dwelling when leading a caravan life, especially in the winter, but when one was travelling, for instance, over the bleak Ordos district and began to look for a night's shelter, and eventually came across a very wretched little yourt, one acquired a distaste for them which was rather apt to colour any remarks one made about them. Personally, he would very much like to have a yourt in England and set it up somewhere in the country—in fact, it might tend to ease the housing problem if introduced into England.

On the motion of the Chairman, a hearty vote of thanks was accorded to the author for his interesting paper, and the meeting terminated.

OLIVE-OIL INDUSTRY IN SPAIN.

Of all olive-growing lands Spain is the most important in the total yield of oil, and is by nature one of those best fitted to fill its own large demands and furnish an increasing supply for export. Italy, the second olive-oil producing country in Europe, has an area planted with olives about a third greater than Spain has, but its yield in normal years is smaller. The French area under cultivation is confined to the Mediterranean coast, and is reported to be decreasing, since greater profits are obtainable from viticulture.

The range of the olive tree in the European-North African region is, roughly, from 46° to 18° north latitude. North of 44° the yield is irregular and generally light. Though the tree flourishes south of 18° the fruit is not of commercial value. Between these limits the olive will thrive wherever a warm, dry climate and moderate rains are found.

All of Spain, lying as the kingdom does between 36° and 44° north latitude, falls in the olive belt; but the region northwest of a line drawn from the French border on the Bay of Biscay to Madrid, and thence west to the Portuguese border, contributes practically nothing to the total. In 1917 and 1918 the following provinces of this region are not reported as having raised any olives: Valladolid, Burgos, Segovia, Soria, Palencia, Leon, Corunna, Guipuzcoa, Vizcaya, Oviedo, and Pontevedra. In all the other provinces olive products are a staple article of commerce. As a rule, the yield is heavier in the provinces of the east and south coasts. The province of Lerida, in Catalonia, is the most important producing centre in the north. Southwest of Madrid, the provinces of Toledo, Caceres, and Badajos have a heavy yield.

By far the most productive region is found in the valley of the Guadalquiver, including the provinces of Jaen, Cordova, and Seville. It is from this district that the heaviest exports of olive products occur. The western portion of this valley, with Seville as a centre, produces the finest table olives as well as large amounts of oil. The eastern section raises olives used almost exclusively for the making of oil. The centre of activity here is in the province of Jaen, which promises to become the premier oil-producing district of the kingdom, if not of the world.

Owing to the high prices received for olive oil in recent years extensive new plantings are being made in all parts of Spain. The total area of land planted with olive trees in the kingdom is estimated in statistics for 1918-19 at 3,851,288 acres. Of the total fruit reported as produced in 1918, 96·6 per cent. was destined for the manufacture of oil.

The amounts of olive oil produced and the chief regions contributing to the total are shown in the table below. The figures are in metric tons, and only those regions are included which, in one or more of the years cited, yielded 10,000 tons or more. The total given is for all the provinces of Spain, and therefore includes other regions in addition to those mentioned in the table.

In an industry so widely diffused as olive-raising in Spain, there are, of course, great contrasts in the conditions under which production occurs. A large part of the agricultural population of the kingdom is engaged in growing olives. In the north a majority of olive producers are owners or cultivators of small holdings upon which olive-raising is only one of a number of sources of income. In the south the orchards reflect the general land-holding conditions; the plantations are larger, the connection of the actual tiller of the soil with the active management of production is less intimate, and specialisation in olives as a source of income is greater.

Cultivation of land between the trees is generally recognised as advantageous. The best opinion is that the ground should be stirred to a depth of 20 to 22 centimetres. Orchards which have been uncultivated before should at first be given shallow ploughing, the depth being gradually increased in succeeding seasons. In this way the roots will by degrees adjust themselves to new conditions, and the loss in the yield which would result from ploughing at once to the depth indicated is avoided. The advantages of cultivation are the avoidance of reduction in fertility and moisture by the vegetation which would otherwise be produced; the increased porosity of the soil, enabling it to hold the winter rains; the loosening of the land so that the roots can grow more freely; and the lessening of surface evaporation. The conservation of moisture is of the utmost importance in the dry regions whose lands are devoted to olive production.

Immediately after the harvest the orchards should be twice thoroughly cross-cultivated to a maximum depth of 20 centimetres, in order to put the land in the best condition to store up the late autumn and winter rains. In the following April or May another stirring is necessary to keep down the spring weeds, the land nearest the trees which cannot be reached by other means being worked up with spades and hoes. In the hot summer months further superficial cultivation is necessary to keep down the weeds and to maintain a dust blanket to impede evaporation.

As in many other lines of industry in Spain, it is possible to find sharp contrasts in the methods of production of olive oil. The most improved appliances may be in use but a few miles from places where the processes employed in almost

Region.	1913.	1914.	1915.	1916.	1917.	1918.
	Metric tons.	*Metric tons.*	*Metric tons.*	*Metric tons.*	*Metric tons.*	*Metric tons.*
Castilla, la Nueva	6,728	10,516	11,934	28,854	28,683	14,391
La Mancha y Estremadura .	13,478	19,917	28,593	*a* 10,643	*a* 16,418	*a* 12,431
Aragon y Rioja	14,267	17,540	17,520	*b* 16,211	*b* 24,657	*b* 18,400
Cataluna	28,075	32,641	26,475	37,439	45,157	36,111
Levante	27,519	3,237	31,517	8,068	32,777	34,566
Andalucia, Oriental . . .	52,845	48,430	81,017	50,185	143,145	75,660
Andalucia, Occidental . .	119,847	68,988	123,415	52,959	133,026	60,817
Total for all Provinces .	265,422	207,764	326,107	207,115	427,836	255,202

a Estremadura only. *b* Aragon only.

prehistoric times persist. In the province of Toledo, for example, the so-called molinos de viga (bean mills), made of tree trunks, are still much used. Compared with modern hydraulic or electric presses these extract, of course, a much smaller portion of the oil content. The machinery used in oil extraction throughout the Peninsula is still comparatively simple, and, except for pistons for hydraulic presses and a few other parts, has been a product of national industry. Almost all the machines are made in Barcelona.

The pressing is usually carried on in small establishments. Oil olives do not appear in large quantities in the open market. A few mills have been established near Cordova and at Mallagon and Tudela in the province of Saragossa. These mills purchase the green olives from the producers and undertake the manufacture of oil from the pressing to its final packing for export. These establishments are exceptions, and even the greater part of their product is, as a rule, made from oil purchased from smaller operators. The usual practice is for the producer to press the oil from his own olives. A few extract oil for their neighbours also. It is then sold to a commission man or direct to the refiner.

According to a report by the United States Commercial Attaché at Madrid, from which the foregoing particulars have been taken, one of the first requisites for high-grade, first-pressing oil is that the fruit be in proper condition, unbruised, and pressed within a very short time after it is picked, preferably the same day it is gathered. Upon this depends the grade of the oil produced, to a much greater extent than upon the character of the machinery used. A large part of the oil-olive harvest is gathered a considerable time before the oil can be extracted and is allowed to deteriorate by fermentation. The result is that the first-pressing oil marketed by large numbers of growers has a much higher acidity than is permissible for the finer grades of oil for export. It is estimated that an amount not greater than 20 or 25 per cent. of the total olive oil produced in Spain can be graded as "aceite fino." One of the reasons alleged for the superiority of oil from certain regions, like that from Tortosa, is that there the number of mills is more nearly sufficient to allow the prompt pressing of the fruit. A very fine grade of olive oil is produced in the northern region near Alcaniz, in the province of Teruel. In Andalusia the region around Velez is famous for the quality of the product.

After the first pressing hot water is added to the pulp, and it is then pressed again, the oil thus extracted being of much lower grade and not entering export trade in unmodified form. There are usually but two pressings, though a third is occasionally given the pulp, the same process being followed as in the second.

Until about twenty-five years ago no important part of the pulp was used in further industrial processes. The pulp was used locally as fertiliser or fuel, or fed to live-stock—especially hogs—as is still the case in many parts of Portugal. Since that time the so-called sulphur-oil industry has developed. The orujo, or pulp left after the above-described pressings, is sold by the producer to the sulphur-oil factories, either directly or through speculators who travel from farm to farm to collect it. These latter not infrequently advance money to the smaller farmers against the orujo which will be produced in the coming crop. The oil content of the residue was formerly greater than at present because of the less effective extracting machines then used. It now averages not over 10 per cent. Nevertheless, the money value of the orujo has risen in recent years, and what was formerly considered almost valueless now contributes an important percentage to the olive-grower's income.

The aceite orujo, or sulphur oil, which is extracted from the pulp, is the basis of the manufacture of a large part of the soap used in Spain, for which it was formerly necessary to use the lower grades of olive oil. Sulphur oil is also exported in large quantities for soap making and other industrial uses.

After the extraction of the aceite de orujo there still remains a brown flaky, charcoal-like substance called picon de orujo, which burns with no smoke, and is used locally in braziers in the winter months to warm dwellings, and to supplement the fuel supply of the soap factories where it is produced. It is also in demand in brick factories because of the high heat which it generates.

The best methods of refining olive oil are found in Andalusia, especially in the Malaga district. Even here it is only recently that modern scientific apparatus has been introduced. Southern oils as they come from the mills are said not to compare favourably with those from Aragon; but, with the present methods of manufacture, the product of Andalusia, when it is ready for export, is claimed to be comparable with the best oils produced in the Peninsula.

The edible oil purchased from the producers by the refiners (who are regularly also exporters) is divided into grades to fix the rate of payment. This is determined chiefly on the basis of the acid content. Oil with less than one-half of 1 per cent. acidity is paid for at the highest rate. Lampant oils must not have an acid content over 3 per cent. Up to that standard the oils are regarded in the local market as edible. The poorer oils run as high as 10 per cent. acid, but these are suitable only for commercial uses. The refineries store the purchased oil in large tanks, often situated under the refinery building, from which it is pumped as required. Formerly the product of the first pressing included all the high-grade oil produced, but with the development of refining processes this has ceased to be the case. The second-pressing oils and poorer grades of the first pressing, when put through the rectification processes, can be brought out light-coloured, with almost no taste and free from acid.

They can then be mixed with the first-pressing oils, which, especially in Andalusia, are too highly fruited for some markets.

In this way it is made possible to produce exactly the blend demanded. The refined oils made from the lower grades thus become a stabilising factor which enables the refiner to keep the brands he establishes of uniform character. The only appreciable difference between the first pressing and the refined oils is in the flavour and the colour. Chemically they are practically identical. As a rule only the fine-grade oils and those grades mixed with refined oil are sold in the United States, where a light-coloured product with little taste is in demand. Fine and medium oils are sold in northern Europe. The medium grade finds a large market also in Argentina and other South American markets. Generally, South America demands oils of high flavour. The corriente grade is sold in Spain and in Cuba.

Among the most important refineries are three in Malaga capable of handling a total of about eighty tons daily. Another will shortly be in operation, and one is under construction at Bobadilla. In Cordoba there is one large olive-oil refinery, and others at Montoro and Mucena in the same region.

INTER-ANDEAN REGION OF ECUADOR.

Ecuador has been divided by nature into three distinct regions—the coast, the Montana, and the Oriente, or eastern slope of the Andes—embracing the headwaters of many of the most important tributaries of the Amazon. Of these three regions, the coast is probably the most important commercially. Its metropolis, and practically the only important port of Ecuador, is Guayaquil. Much of the coast region is inundated during the wet season, which commences usually in December. The Oriente, though perhaps richer in possibilities than any or all of the other portions of the country, is at present wholly undeveloped, and accessible only to expeditions specially equipped for exploration of the wilderness. There remains the Montana, or Andean, region, regarding which the following particulars have been furnished by Mr. H. L. Smith, Special Assistant, State Department, Guayaquil.

The inter-Andean region of Ecuador, except a small portion south of Cuenca, is something less than 250 miles long, and is from 8,000 to 12,000 feet above the sea, from which it is separated by the very difficult western Cordillera, pierced here and there, but not often, by gorges. These gorges are, in general, so steep, with such precipitous walls and so rugged as to be impracticable as outlets for railways, cart roads, or even trails. With the exception of one railway of recent construction, there are nothing but trails as means of access from the coast to the valley-plateau.

These trails, extremely primitive, difficult, and dangerous, but called "caminos," or roads by the inhabitants, wind over the surface of the mountains to passes from 12,000 to 14,000 feet high, from which they descend to the central valley. Over these trails, burros, mules, and, to a limited extent, small horses, can carry 200 pounds or a little more of freight carefully balanced on their backs. Until the advent of the one railway from Guayaquil to Quito they constituted the sole means of access to the world, and still so constitute it to all portions of the valley not accessible to the railway. The valley closes both to north and south within the limits of Ecuador in nests of mountains that for all practical commercial purposes preclude entrance from either Peru or Colombia. On the eastern side of the valley it seems that the slopes of the eastern range are gentler, the gorges less precipitous, and that entrance from that side would be considerably easier. But this is of no practical importance at present.

As far as is known, this region is without valuable mineral deposits, though an inferior grade of coal and what seems to be a good quality of kaolin and marble are found in the southern part of Azogues. It must be borne in mind, however, that the country has been prospected only to the most limited extent, and as it is known that many of the rivers of the Oriente are auriferous, it is possible that the eastern of the two ranges that bound the valley will be found to be gold-bearing when they have been more thoroughly explored.

Generally speaking, the valley is devoid of trees; but the eucalyptus, introduced some forty years or more ago from Australia, seems to thrive here even better than in California, and plantations of it are continually being extended.

The growth of the tree is so rapid that it may be profitably cut every five years, being then worth 5 sucres, about 10*s.* Each one, therefore, produces 2*s.* worth of wood per year, when thus cut, and, as the trees may be planted from 6 to 10 feet apart, the yield each year per acre on the average would vary between £44 and £120. The eucalyptus tree shoots up rapidly from the root when it is cut, so that a plantation lasts indefinitely, differing in this respect from nearly every other useful wood. It is the usual fuel of the country, either dried or converted into charcoal; it is used in the locally made furniture, and for such wood as is used in building construction.

The rainfall of the Montana, even for places of the same altitude, varies more than would be supposed. In general, it is deficient, especially during the verano (summer, or dry, season), from the first of July to about Christmas time. The term invierno (winter) is applied to the wet season, say from 1st January to 1st July. These changes of season are, however, by no means fixed; they vary from year to year and from one part of the region to the other. It will then readily be inferred that much of the country presents a desert aspect, and is characterised by desert vegetation—cactus, agave, yucca, broom—and by drifting sands and scanty herbage. The more elevated regions, say, above 11,500 ft., locally called paramos, are, in general, sufficiently

watered at all times by the clouds and fogs that rest upon their surface. Vegetation is there limited by temperature rather than dryness, and the paramos are covered with clumps of a coarse and wiry grass called paramo grass, which cattle are said to like when it is young.

Agriculture, including the raising of stock, is the industry of the region, and the crops raised are those of the temperate zone. The small grains, maize, potatoes, varieties of beans, and alfalfa are the principal crops, with some fruit of an inferior sort raised near Ambato. Practically all the agricultural work is done by Indians either on small tracts owned by them or on large haciendas.

Agricultural methods are very primitive. About 99 per cent. of the ploughing in Ecuador is nothing more than a shallow stirring of the surface of the soil by a sharpened board with an iron point drawn by a team of oxen and furnished with an iron handle, with which the farmer keeps the plough upright. There is no pretence of turning over the ground; it is simply slightly furrowed. The agricultural lands of this region have never been turned over or even stirred to a depth of more than 4 or 5 inches. Nor have they ever been fertilised. There are no barns or barnyards. There are vast herds of cattle, but the climate makes all shelter superfluous, and they live the year round on pastures which have never been ploughed.

Farming operations consist in the depositing of the seed in the land. The crop is cultivated with mattocks and an instrument like a heavy crowbar flattened at one end into a broad chisel 4 or 5 inches wide. Probably there does not exist in the whole district an instrument for horse or other power cultivation. Of course the crops obtained by this cultivation are small and wholly inadequate.

Irrigation seems to be managed with a fair amount of skill, and in one respect the Andean farmer is unexcelled—the utilisation of hillsides.

Most of the well-watered surface of the valley is devoted to cattle-raising. The cattle are raised on large estates or haciendas consisting frequently of many thousands of acres covering the valley and running far up the mountain slopes. The cattle live in the pasture the year round, and are sold from the pasture without any further fattening or attention. Few of the haciendas possess the amount of stock they are capable of supporting, so that the industry is capable of considerable expansion.

There are few manufactures in the Montana region, the chief being some small potteries and a few textile factories. Apart from these there is a cigar, cigarette and match factory in the Chillo Valley, some 10 or 15 miles from Quito.

Any great development of modern industry or commerce will be dependent upon an improvement of transportation facilities. One railway, with grades running up to 6·5 per cent., the operation of which is seriously interrupted in the rainy season, now connects a portion, not over half, of this valley with the coast. The maximum goods train on this line consists of four trucks.

Within the valley itself there are a few trails, especially in the northern part, that might easily be made feasible for carts. Some of them are so used to a limited extent at the present time. About forty-five years ago a longitudinal road within the valley, with substantial bridges, and wide enough for wheeled traffic from Quito to Riobamba, a distance of about 125 miles, was constructed. This is the sole road professedly for vehicles in the region described. Only the crudest and most perilous trails exist between the valley and the coast.

Obviously a preliminary to any great development of the valley will be better communications, not only between different parts of the valley, but also between the valley and the coast. Accordingly, various schemes for railways have been broached, at least two connecting Quito with different points on the coast, and one extending the existing longitudinal system to Cuenca. The construction of two of these has been begun as a Government undertaking, but is not completed. A third line to pierce the eastern cordillera and connect Ambato with the Oriente has also been started.

NOTES ON BOOKS.

FOREST WOODS AND TREES IN RELATION TO HYGIENE. By Augustine Henry, M.A., F.L.S. London: Constable and Co., Ltd. 18s. net.

This volume forms part of the Chadwick Library, a valuable and gradually growing collection of books springing out of the lectures which are constantly being given under the Chadwick Trust.

Popular ideas as to the effect of trees on sanitation are apt to be vague. Most people have views upon the subject—some, exceedingly strong ones; but probably few could give scientific grounds for the theories which they advance. Dr. Henry, Professor of Forestry at the Royal College of Science, Dublin, has endeavoured to state the case fairly, and he supports his arguments by a mass of well-ordered information. He begins by describing the far-reaching influences of forests and trees on climate, flow of water, soil erosion, shelter from wind, purity of air and water, etc. —all influences directly affecting our health and comfort. He then proceeds to discuss the value of forest districts as sites for sanatoria. Forest air is free from injurious gases, dust, particles, and bacteria, while the soil is hygienically pure. Tubercular patients require open-air treatment, and at the same time should be protected against cold or severe wind, which raises dust and generally increases cough and dyspnœa. Such protection is best afforded by pine trees, which have been recognised since the days of Pliny as having a beneficial effect on people with a tendency to phthisis.

Professor Henry is a staunch believer in the value of trees in towns, where their beauty of

colour and form exercises a powerful if sometimes unconscious effect on the townspeople. He goes into some detail in describing which trees will thrive in city surroundings, and which will not; and he has an interesting chapter on the afforestation of pit mounds, on which unpromising soil some surprisingly good results have been obtained. The greater part of the book is devoted to the question of the afforestation of catchment areas; and here will be found a large quantity of detailed information showing the kinds of trees most suitable for different situations, and particulars of a very large number of such areas scattered throughout the United Kingdom.

GENERAL NOTE.

Glauber's Salt in Siberian Lakes.—The following is an estimate of supplies of precipitated Glauber's salt in some of the Siberian lakes, quoted by the American Department of Commerce from a Vladivostok economic journal: (1) The Great Marmyshansk Lake—144,000,000 pouds (2,592,000 tons of 2,000 lb.) of crystalline salt ($Na_2SO_4 10H_2O$), and 22,000,000 pouds (396,000 short tons) of evaporated Glauber's salt; (2) Little Marmyshansk Lake—25,000,000 pouds (450,000 short tons) of crystalline salt; (3) Lake Tuskal (Minusinsk district)—up to 100,000,000 pouds (1,800,000 short tons) of crystalline salt; (4) Lake Varche (Minusinsk district)—up to 100,000,0 00 pouds of precipitated crystalline salt, and an enormous quantity of Glauber's salt in solution.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

April 14.—Joseph Thorp, "The Fundamental Basis of Good Printing." Sir Herbert Morgan, K.B.E., will preside.

April 21.—Air-Commodore Edward Maitland, C.M.G., D.S.O., A.F.C., "The Commercial Future of Airships." The Marquess of Londonderry, K.G., M.V.O., Under-Secretary of State for Air, will preside.

April 28.—Brigadier-General Charles H. Sherrill, LL.D., "Ancient Stained Glass." The Right Hon. Lord Desborough, K.C.V.O., will preside.

May 5.—Dr. C. E. Kenneth Mees, "A Photographic Research Laboratory." Sir Henry Trueman Wood, Chairman of the Council, will preside.

May 12.—Graily Hewitt, "Rolls of Honour."

May 19.—John Somerville Highfield, M.Inst.C.E., M.I.E.E., "Electrical Osmosis." Alan A. Campbell Swinton, F.R.S., will preside.

Indian Section.

Thursday afternoon, at 4.30 p.m.:—

April 15.—Sir George Cunningham Buchanan, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development." The Right Hon. E. S. Montagu, M.P., Secretary of State for India, will preside.

Thursday afternoon, at 5 p.m.:—

May 20.—Brigadier-General Lord Montagu of Beaulieu, C.S.I., "Roads and Transport in India."

Monday afternoon, at 4.30 p.m.:—

May 31.—Albert Howard, C.I.E., M.A., A.R.C.S., F.L.S., Imperial Economic Botanist to the Government of India, "The Improvement of Crop Production in India." Sir Robert W. Carlyle, K.C.S.I., C.I.E., will preside.

Date to be hereafter announced:—

Sir Valentine Chirol, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

Colonial Section.

Friday afternoon, at 4.30 p.m.:—

May 28.—Professor William A. Bone, D.Sc., Ph.D., F.R.S., "Lignite."

Indian and Colonial Sections.

(Joint Meeting.)

Friday afternoon, at 4.30 p.m.:—

June 4.—Professor Sir John Cadman, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E., "The Oil Resources of the British Empire."

Cantor Lectures.

Monday evenings, at 8 p.m.:—

Walter Rosenhain, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys."

Syllabus.

Lecture I.—April 12.—Production of aluminium—Raw materials—Purification—Reduction process—Purity attainable—Deleterious impurities—Properties of pure aluminium in the cast and rolled state—Uses of pure aluminium—Its advantages and defects.

Lecture II.—April 19.—Aluminium alloys—Combination of strength and lightness—"Specific tenacity"—Alloys with copper, with zinc, and with zinc and copper—Constitution, microstructure,

and physical properties in cast and wrought states —More complex alloys—Containing magnetism—Limitations to the use of magnetism—"Hardening" alloys.

LECTURE III. — APRIL 26. — Special Uses of aluminium alloys—Castings for automobile and aeroplane parts—Castings for aero-engines—Pistons and piston alloys—Properties at high temperatures —Automobile and aero-cylinders — Other engine parts—Structural uses—Rigid airships, aeroplane spars, and wing-coverings—Possible future developments.

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.
May 3, 10, 17.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, APRIL 12... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Dr. W. Rosenhain, "Aluminium and its Alloys." (Lecture I.)

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Rev. J. E. H. Thomson, "The Pentateuch of the Samaritans: when they got it, and whence."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Society of, at the Geological Society, Burlington House, W., 5.30 p.m. Professor E. R. Matthews, (a) "Flood Prevention Works at Troon, Ayrshire; (b) The Action of Sea Water on Concrete."

Chemical Industry Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. 1. Dr. W. E. Brenchley and Mr. E. H. Richards, "The Fertilising Value of Sewage Sludges." 2. Dr. E. P. Perman, "A New Test for Incorporation." 3. Messrs. T. M. Lowry and L. P. McHatton, "Experiments on Decrepitation."

Geographical Society, Kensington-gore, W., 5 p.m. Colonel Sir Sidney Burrard, "A Brief Review of the Evidence upon which the Theory of Isostasy is based."

British Architects, Royal Institute of, 9, Conduit-street, W., 8 p.m. Mr. J. Begg, "Architecture in India."

TUESDAY, APRIL 13...Electrical Engineers, Institution of (Scottish Centre), 207, Bath-street, Glasgow, 7.30 p.m. Squadron-Leader J. Erskine-Murray, "Wireless Telegraphy."

Royal Institution, Albemarle-street, W., 3 p.m. Major G. W. C. Kaye, "Recent Advances in X-Ray Work." (Lecture I.)

Alpine Club, 23, Savile-row, W., 8.30 p.m.

Civil Engineers, Institution of, Great George-street, S.W., 5.30 p.m. 1. Lieutenant-Colonel J. K. Robertson, "Richborough Military Transportation Depot." 2. Major F. O. Stanford, "The War Department Cross-Channel Train-Ferry."

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 3 p.m. Annual General Meeting.

Photographic Society, 35, Russell-square, W.C., 7 p.m. 1. Mr. A. C. Banfield, "Prisms." 2. Mr. A. J. Munro, "Machinery used in the Manufacture of Photographic Plates."

Anthropological Institute, 50, Great Russell-street, W.C., 8.15 p.m. Mr. A. O. Neville, "The Western Australian Aborigines, their Treatment and Care."

Zoological Society, Regent's-park, N.W., 5.30 p.m. 1. Mr. A. Willey, "An Apodous *Amia calva*." 2. Messrs. H. A. Baylis and C. Lane, "A Revision of the Nematode Family *Gnathostomidæ*." 3. Dr. W. J. Dakin, "The Onychophora of Western Australia." 4. Mr. A. M. Altson, "The Life-history and Habits of Two Parasites of the Blow-fly."

Colonial Institute, Central Hall, Westminster, S.W., 8 p.m. Mr. C. Turnor, "The Organisation of Migration and Settlement within the Empire."

Horticultural Society, Vincent-square, Westminster, S.W., 3 p.m. Dr. A. B. Rendle, "Plants of Interest in the Day's Exhibition."

Chadwick Public Lecture, at the Royal Sanitary Institute, 90, Buckingham Palace-road, S.W., 8 p.m. Sir Daniel Hall, "Gardening and Food Production." (Lecture I.)

WEDNESDAY, APRIL 14 ... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. J. Thorp, "The Fundamental Basis of Good Printing."

Aeronautical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Paper by Major-General Sir W. S. Brancker.

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Mr. A. E. Parkes, "The Turbidity Temperature of Fats, Oils, and Fatty Acids." (Part II.) 2. Dr. G. W. Monier-Williams, "The Interpretation of Milk Records." 3. Messrs. A. F. Joseph and G. A. Freak, "The Loss of Free Ammonia from Drinking Water Samples." 4. Mr. E. Sinkinson, "A Decanting and Filter-Washing Machine."

Automobile Engineers, Institution of, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. Dr. W. H. Hatfield. "The Most Suitable Steels for Automobile Parts."

United Service Institution, Whitehall, S.W., 3 p.m. Lieutenant-Colonel J. Shakespear, "Recent Events on the Assam Frontier."

THURSDAY, APRIL 15...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Sir George Cunningham, "The Ports of India: their Administration and Development."

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. 1. Captain F. K. Ward, "Natural History Exploration on the North-East Frontier of Burma." 2. Mr. R. Paulson, Exhibition of Lantern-slides illustrating definite stages in the sporulation and gonidia within the thallus of the lichen *Evernia Prunastri*, Ach.

Child Study Society, at the Royal Sanitary Institute, 90, Buckingham Palace-road, S.W., 6 p.m. Professor W. Ripman, "Spelling Reform."

Chemical Society, Burlington House, W., 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. S. Skinner, "Ebullition and Evaporation." (Lecture I.)

Camera Club, 17 John-street, Adelphi, W.C., 8.30 p.m.

Electrical Engineers, Institution of, Victoria Embankment, W.C., 6 p.m. Dr. C. V. Drysdale, "Modern Marine Problems." (Kelvin Lecture.)

Numismatic Society, 22 Russell-square, W.C., 6 p.m.

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, W., 5.30 p.m. Presidential Address by Mr. F. Merricks, "The Mineral Production of the Empire."

FRIDAY, APRIL 16...Technical Inspection Association, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.30 p.m. Mr. F. R. Wade, "Labour Unrest—its Causes and its Cures."

Royal Institution, Albemarle-street, W., 9 p.m. Dr. J. A. McClelland, "Ions and Nuclei."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 6 p.m. Mr. E. F. Etchells, "Submission of Plans to Local Authorities."

SATURDAY, APRIL 17...Royal Institution, Albemarle-street, W., 3 p.m. Dr. W. H. Eccles, "The Thermionic Vacuum Tube." (Lecture I.)

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FRIDAY, APRIL 16, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, APRIL 19th, at 8 p.m. (Cantor Lecture.) WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." (Lecture II.)

WEDNESDAY, APRIL 21st, at 4.30 p.m. (Ordinary Meeting.) AIR-COMMODORE EDWARD MAITLAND, C.M.G., D.S.O., A.F.C., "The Commercial Future of Airships." THE MARQUESS OF LONDONDERRY, K.G., M.V.O., Under-Secretary of State for Air, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, April 12th, DR. WALTER ROSENHAIN, F.R.S., delivered the first lecture of his course on "Aluminium and its Alloys."

The lectures will be published in the *Journal* during the summer recess.

SIXTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 14th; SIR HERBERT EDWARD MORGAN, K.B.E., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Abbott, Hon. R. H. S., Bendigo, Victoria, Australia.
Allen, William Thruston, Waipiro Bay, New Zealand.
Buchanan, John, Port Sunlight, Cheshire.
Cross, L. W., London.
Hitchcock, Eldred Frederick, C.B.E., London.
Mansukani, Gulab, M.B., B.S., London.
Marshall, Mrs. M. Katherine, Totley, nr. Sheffield.
Mather, Frederick, B.Sc., Barcelona, Spain.
Matsukata, Goro, Tokyo, Japan.
Savi, Ernest E., London.
Taylor, Captain T. Smithies, Steep Petersfield, Hants.
Wheeler, Major Charles, R.A.S.C., O.B.E., M.I.A.E., Bushey, Herts.
Yorke, Mrs. Constance E., F.R.G.S., Southsea, Hants.

The following candidates were balloted for and duly elected Fellows of the Society:—

Barker, Frederick Walter, London.
Barnsley, Frank Herbert, Dudley.
Burlin, Adolph L., Ph.D., Manchester.
Butterworth, Charles Frederick, Poynton, near Stockport.
Corker, James S., Manchester.
Farrar, George Edward, Richmond, Surrey.
Hoffman, Frederick L., LL.D., Newark, New Jersey, U.S.A.
Lomas, Leslie H., B.Sc., Prestbury, Cheshire.
Oxley, Ernest C. F., Sioux Lookout, Ontario, Canada.

A paper on "The Fundamental Basis of Good Printing" was read by MR. JOSEPH THORP.

The paper and discussion will be published in a subsequent number of the *Journal.*

INDIAN SECTION.

THURSDAY, April 15th; THE RIGHT HON. E. S. MONTAGU, M.P., Secretary of State for India, in the chair. A paper on "The Ports of India: their Administration and Development" was read by SIR GEORGE CUNNINGHAM BUCHANAN, K.C.I.E., M.Inst.C.E.

The paper and discussion will be published in a subsequent number of the *Journal.*

COVERS FOR JOURNALS.

For the convenience of Fellows wishing to bind their volumes of the *Journal*, cloth covers can be supplied, post free, for 2*s.* each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

THIRTEENTH ORDINARY MEETING.

WEDNESDAY, MARCH 10th; SIR ROBERT A. HADFIELD, Bt., D.Sc., F.R.S., in the chair.

THE CHAIRMAN, in opening the meeting, referred to the illness of Sir Dugald Clerk, one of the greatest gas engineers in the country, and said he was sure all those present would wish him to send their sincere sympathy to Sir Dugald, and their hope that he would speedily recover. Before calling upon Mr. Thornton to read his paper, he would like to make one or two preliminary remarks. The importance of economising the fuel supplies of this country, and making the best of our means of producing what was called heat, was shown by the latest statistics available. For example, the President of the British Association mentioned at the Bournemouth Meeting that the latest estimate of the total water-power in the British Isles was only 1½ million h.p., and that England only possessed 1 per cent. of that horse-power, and only 2½ per cent. of the total coal in the world. Whilst that was startling, it helped to show that all possible endeavours should be made to save fuel consumption, and to make that consumption of as great efficiency as possible. "Many a mickle makes a muckle," and so in the technical world, by paying attention to the small things, we were able to economise and make the most of what was given to us by Providence. Many propositions had been suggested; for instance, the late Mr. B. H. Thwaite very strongly put forward—and there was some reason in his contention—that power should be developed at the coal mines *in situ*. Why should the coal be hauled from the pits in which it was found and a great deal of money be spent in distributing it, when central power-stations could be provided close alongside the coal, at the bottom of the shaft, and out of the way of hostile aircraft? That seemed a very attractive arrangement, and yet it was thirty years since Mr. Thwaite and others put forward the suggestion, and he was not aware of a single instance where it had been put into practice—at any rate not on a large scale. Sir Charles Parsons suggested boring a hole in the crust of the earth for a depth of ten or twelve miles to obtain the earth's latent heat, but, although there was probably nothing insurmountable in that proposition, it was doubtful whether it would be tested in practice for a long time to come. One might run through a whole gamut of suggestions, many of them containing apparently the germs of important economy, but still nothing was done. If it took this country generations to settle down to such a sensible project as having a Channel tunnel, how long would it take it to consider the excellent suggestion of Sir Charles Parsons? We were ready to waste millions annually in wild-cat schemes, in many cases rejecting the views of the wise men amongst us. In any case, however, we could try to effect economy in present practice, and in that respect he thought Mr. Thornton had done great work, by means of his lectures and the products of his firm, in bringing about many very useful economies. When he (the Chairman) was President of the Society of British Gas Industries, he offered a prize with a view to stimulating interest in that important question, and quite a number of useful theses were submitted, the prize being awarded to Mr. F. W. Epworth, of the Richmond Gas Stove and Meter Company, for a most valuable paper on "The Utilisation of Gaseous Fuel in Commercial Practice." With regard to the question of the value of coal, the exports of coal in January, 1919, and January, 1920, were respectively 2¼ million tons and 3½ million tons, with values of £4,000,000 and £11,500,000 respectively, that being an average price per ton of 34*s*. 8*d*. and 68*s*. 9*d*.—the latter figure brought home to us the great desirability of economising our heat products in every possible shape and form. It was interesting to note that the total production for the present year was estimated at 230,000,000 tons, of which it was estimated that 49,000,000 tons would be for export and bunkers and 181,000,000 tons would be for inland purposes. It was hoped that the miners would do their share in the present reconstruction period and settle down to really useful and hard work. There was one crumb of comfort in regard to the labour situation, namely, that in January only 184,000 days were lost by disputes which began during that month. That was very satisfactory, in view of the fact that in January, 1919, 3,000,000 days were lost in that way. That showed the serious amount of waste that prevailed not only in materials but on the human side, and it was to be hoped that the recent improvement would be maintained.

The paper read was—

GAS IN RELATION TO INCREASED OUTPUT AND NATIONAL ECONOMY.

By H. M. THORNTON, J.P., Assoc.Inst.C.E.

Five years ago I read a paper before your Society detailing the very varied and important uses of coal gas for industrial purposes. This was followed in 1917 by a review of some of the valuable services rendered to the nation by coal gas during the strenuous days of the war. To-day I wish to continue the story, and show the application of gas to peace-time conditions, and particularly the contribution it has to offer to the difficult problem of production which confronts the manufacturer to-day. The use of gas for manifold industrial purposes was not a mere war-time improvisation; and, unlike some of the features of that stressful time, its value has not vanished with the return of peace, and its power has not diminished with the cessation of the demand for munitions of war. Rather

as the outcome of satisfactory experience in many realms of industry, and of confidence built on a foundation of good work rendered at a critical period, its prestige stands higher, its applications are more widely known, its possibilities are more appreciated by manufacturers, and the universality of its service is more generally realised.

In common with other of our important industrial utilities, coal gas for manufacturing processes may be said to have come into its own during the last five years or so. Not that gas was unused for industrial work before 1914, or its value unrecognised. But war conditions gave it an impetus that it might never have received in peace time; and more progress, in its adaptation to manifold processes, was made in five years than in the previous fifty. It is highly important that such agents as this, whose national contributions were of such magnitude and of such a notable standard of usefulness, should be harnessed to the work of reconstruction; that advantage should be taken of the increased knowledge gained of their abilities; and that their possibilities of future service should be exhaustively explored. Especially is this necessary at this time when our national position demands that every individual shall give his best efforts, and that every piece of machinery and every natural resource shall be developed and utilised to their utmost capacity for increasing production. This, indeed, is the text of the utterances of statesmen, employers, and of leaders of labour. With a unanimity which is as remarkable for its spotaneity as for its widespread character, the call is for production, increased production, intensive production. Our Chairman of this afternoon (Sir Robert Hadfield), when recently welcoming the Prime Minister to Sheffield, put the case very concisely and definitely when he said: "The world cannot get on its feet again until we recognise the principle of supply and more supplies." To employers and to employees the call comes alike. The responsibility belongs to both capital and labour; and the opportunities for meeting the national demands are available to both parties in industry. The manufacturer who deliberately keeps a machine idle, or who neglects to install the most efficient and modern machines, is as unpatriotic as the worker who "slacks."

The nation at present is not paying its way; our expenditure is greater than our income, and a heavy load of debt is still accumulating. We must recognise that the war destroyed goods and material worth probably £50,000,000,000, and reduced man power, which is the power of production, by probably 10,000,000. Of these losses, both in material and men, Britain willingly gave her full share.

To the aim of improving our national position, the best thought and energy of us all must be directed. We *must* have more output—more coal, more bricks, more cloth, more ships, more engines, more foodstuffs, more everything! It is only in this way that the brighter England can be realised, that prices can fall, that taxation can decrease, that industrial conditions can become stable, and that we can reap the great harvest that awaits us. The whole world clamours for the products of our factories. We have the supreme opportunity of our history. The next few years hold promise of being the greatest in British trade. Everything is contingent on, first, exercising a reasonable economy; and, secondly, and perhaps paramountly, producing more. He who can make "two blades of grass grow where only one grew before" was never worthier of the thanks of the community than now.

I think there will be agreement with the general survey of the position which I have so far made; and so we may turn from the general to the particular.

Let us look directly to the contribution which coal gas offers to the manufacturer and to his employees in their joint efforts to solve the great national problem of increased production. Many agents will need to be called in to assist, but none has a greater willingness nor a greater ability to serve than the commodity we are considering this afternoon. It touches the life of the community at every point; its ramifications extend directly or indirectly into every field of industry. I want to consider its services to the manufacturer and his employees and to the nation in its great task of economy, and the upbuilding of a stable economic position.

In the time available it is clearly not possible to deal with all branches of industry. The complete story, though full of interest, would be far too long for one paper. I shall therefore largely confine myself, as in my last paper, to the subject of the heat treatment of metals, as an example of the aid which gas contributes in all manufacturing processes. The output of machinery of all kinds and types is urgently needed to-day, as it is by its help that we can compensate in considerable degree

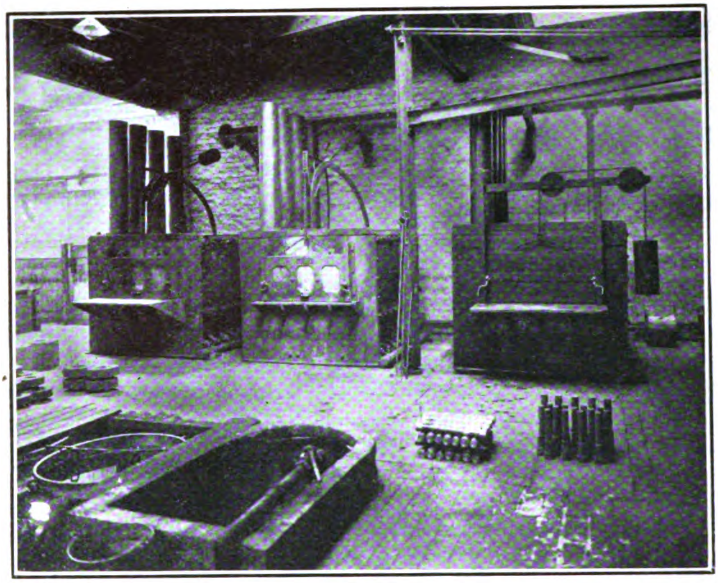

Fig. 1.—Richmond's Natural Draught Oven Furnaces at a Machine-tool Works.

methods are being adopted with the object of eliminating waste; the day of the monumental "scrap-heap" is passing. Scientific organisation has shown the way to the avoidance of "rejects" and "faults"; to the utilisation of "waste" material. As an example of the latest methods in the elimination of waste, we cannot do better than look at a heat-treatment shop of one of the leading firms of machine-tool makers (Fig. 1). It is especially fitting that we should take this as our first illustration in view of the supreme place (as already mentioned) that machinery must take in all efforts to improve production. It is partly to a larger use of modern machinery that we must look for enhanced results, and upon the quality and quantity of its production all other industries are dependent. It is therefore satisfactory to reflect on the large number of makers of the highest grade of machine tools who rely on gas for the careful heating necessary for their production. Parts for machine tools require a high standard of mechanical accuracy, and obsolete methods of heat treatment are an obstacle to the attainment of this. It will be noticed at once that all furnaces are fired with coal gas, the reasons for which will be apparent when we consider the intricate process of the heat treatment which is necessary for gears. These are first annealed at 750° C., for six to eight hours, and slowly cooled. They are then, after other processes have been carried out, carburised at 900° C., given four hours' soaking, and allowed to cool down. Each gear is then reheated—first at 850° C., and quenched in oil; and again at 750° C., and quenched in oil. This method has been found to reduce to practically nil the number of rejects for distortion; such large gears as 14-in., and even 18-in. diameter spur wheels being successfully treated.

Another important part of a machine tool, viz., the spindle, calls for very exact and scientific heat treatment. It is carburised at 900° C. for six hours, and cooled out. After further machining, the spindles are reheated in the furnaces (shown) at 850° C., and

for the loss of labour in the war, the reduction of hours per week, and the natural inclination of workmen to desire less strenuous occupation. The heat treatment of metals is, therefore, of primary importance in assisting the output of machines, tools, and labour-saving and cost-economising devices. All the industries of the country, great and small alike — cotton, wool, cloth, leather, glass — could, did time permit, be similarly passed in review, and the results of increased production by the use of gas, which I shall show in the case of the metal industry, equally apply to any and all of them. Heat is a universal necessity in manufacture, and coal gas is the most adaptable and efficient means of providing that heat, and it enables the fullest possible value to be obtained from the coal used.

Dealing, then, with the question of how gas can help production in the heat treatment of metals, I will, for convenience, divide my remarks under four heads:—

1. The eliminating of waste;
2. The cheapening of production;
3. The "speeding-up" of output;
4. The human element, improvement in working conditions;

all of which, in their respective spheres, mean increased production.

1. The Eliminating of Waste.

This is a very vital component of the effort to improve output. Waste means loss. Modern

quenched in water; and again reheated at 750° C., and quenched in water. Many other parts used in modern machine-tool production are also heat-treated in the furnaces portrayed —such as ball and twist races, indexing parts of turrets, springs, plungers, worms and worm wheels, all types of speed-changing gear and clutches, etc.

You will, I am sure, have been impressed by the importance of the heat-treating operations, by the stress laid on the attainment and maintainment of exact temperatures previously defined as necessary for the perfect product; and the same applies to every trade or industry where heat treatment of metals is necessary. It can readily be seen that it is the easy and perfect control that gas affords that enables such an exacting standard to be met continuously, and such excellent results to be obtained day in and day out, with a minimum of waste.

As another illustration of the help to increase production by the avoidance of losses, I would refer you to the motor industry. On the screen is a picture of the heat-treatment department of a world-famous motor-engine works (Fig. 2). In this class of work, as will be readily understood, such vague terms as "dull red" or "forging heat" are not admissible, meaning, as they do, anything within a range of 40° to 50° C. Operations have to be carried out at a definite temperature; and the limits allowed are within a very few degrees. If these narrow limits are exceeded by an infinitesimal amount the component part must be scrapped. It is therefore of vital importance to output to see that variations of temperature do not occur.

For this reason I think it will be of interest to you to note briefly the steps in the heat treatment. Normalising is the first operation. The part is heated to 780° C., and quenched in oil. It is then heated to 830° C., and again quenched in oil. The final heating is at 560° C., and thereafter the shaft is quenched in water. The stamping is made sufficiently long to allow test-pieces to be cut from both ends. A test-piece is turned from one end. This piece is cut into two, and one portion is tested for tensile strength, and the other is subjected to an impact test. The test-piece from the other end is tested for fracture. In addition to these tests, a "Brinell" reading is taken on each end of the shaft proper. This treatment is designed to guarantee that all parts of the shaft have been subjected to the same heating conditions; and after it has been completed the rough machined stamping is passed into the machine shops for finishing.

The refinement of heat treatment, it will be seen, is remarkable; but I am assured that, thanks to the constancy provided by the gas furnace, the number of "rejects" is a very small percentage of the total output. A word or two on the design of the furnaces (shown) will be of interest. They are chiefly of the natural-draught regenerator type, a cross-section of which is now on the screen. Special high-power Bunsen burners are employed, the burner mouths being sealed from the air at the point of entrance to the combustion chamber. Primary air is admitted to the burner, and controlled by an air-adjuster; while combustion is supported by air (pre-heated by radiation

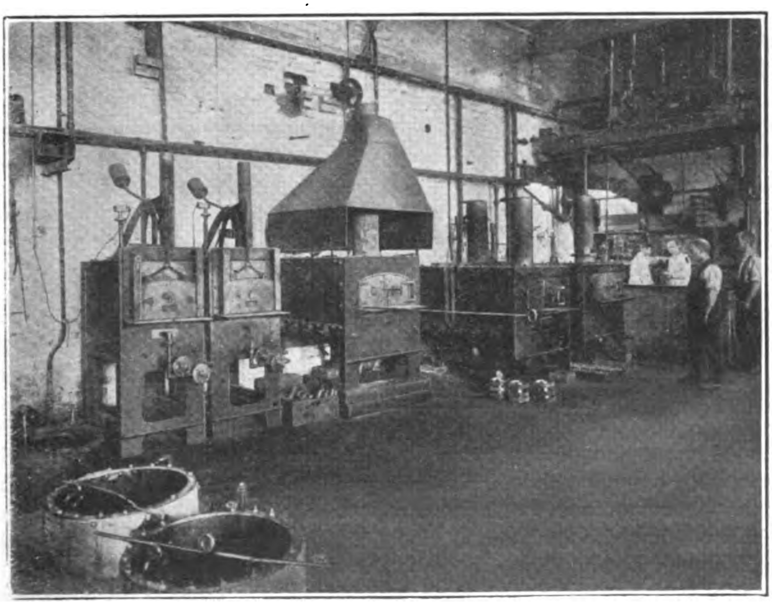

Fig. 2.—Heat-treatment Shop of a World-famous Motor-engine Works.

from the floor of the furnace) entering the combustion chamber by a series of air-nostrils. The next picture of this furnace enables me to point out these secondary-air valves more clearly. These valves constitute a vital part in the regulation of an even temperature throughout the whole oven, which uniformity is assured by this type of furnace. It will be observed that every burner has its own secondary-air valve, and it will be appreciated that this arrangement enables exact adjustments to be effected with facility.

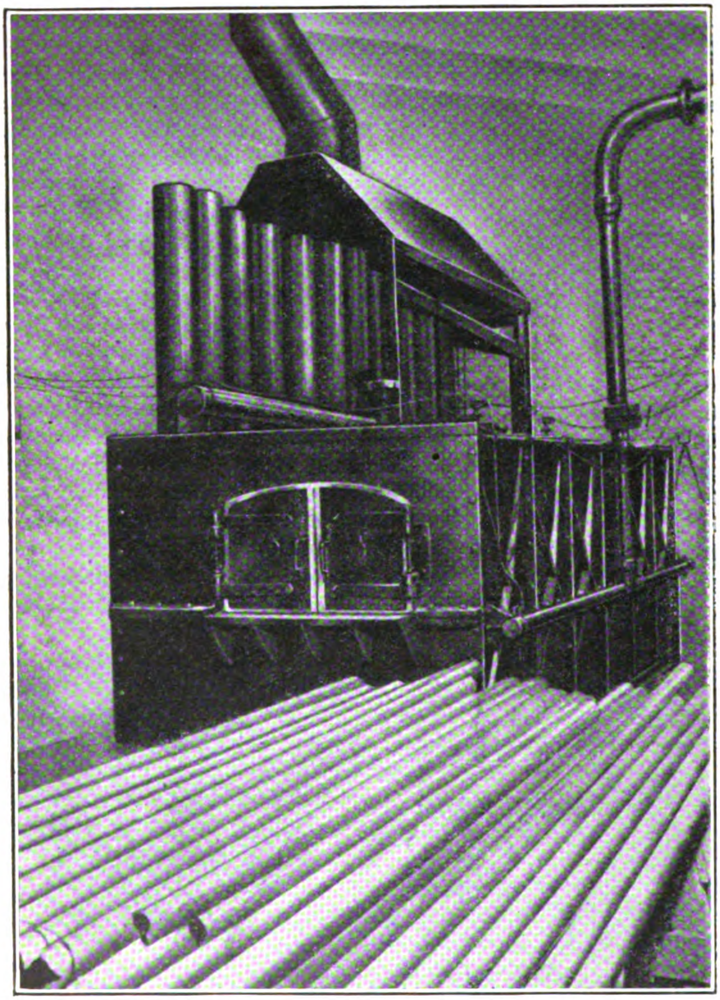

FIG. 3.—RICHMOND'S "L.P.G.A." OVEN FURNACES FOR ANNEALING 7-TON CHARGES OF HIGH-SPEED STEEL.

I have dealt briefly with the avoidance of waste from losses in the work undertaken, which has been accomplished by ensuring correct temperatures by the aid of such an easily manipulated fuel as gas. There is another element of possible wastage, however, that must be considered, viz., the spoiling of the work by incorrect atmospheric conditions in the method of heat treatment. All interested in the numerous thermo-treatments of steel will be aware of the emphasis placed on this point by experts. A decarbonising atmosphere, for instance, in the treatment of a cam shaft would result in the complete waste of much time, labour, and highly expensive material. Similarly, a reducing atmosphere at the wrong time is fatal to the accurate results required. In this connection, I do not know of any fuel which can give more satisfactory results than gas. Undoubtedly one of the main recommendations for gas for Sheffield steel works, and indeed for all treatment of metals, is the ease and certainty with which the conditions desired can be realised — not by guess work or exhaustive trial, but by simple adjustment of the furnace, and this obtained day after day, exactly the same, without variation. The picture on the screen (Fig. 3) is of a furnace annealing high-speed steel in Sheffield (in which city, I may mention, over 2,000 gas furnaces are in use). You will be interested to know that this particular furnace, up to the time the photo was taken, had annealed 311 charges, of about seven tons per charge, the aggregate weight, therefore, being approximately 2,200 tons. During the whole of this work, which was carried out at a temperature of 1,000° C., the only attention required by the furnace was the cleaning of the flues and the replacing of a few guard tiles, which were very small matters. The type of furnace shown by this slide is the patent "L.P.G.A." (low-pressure gas and air), and with this design

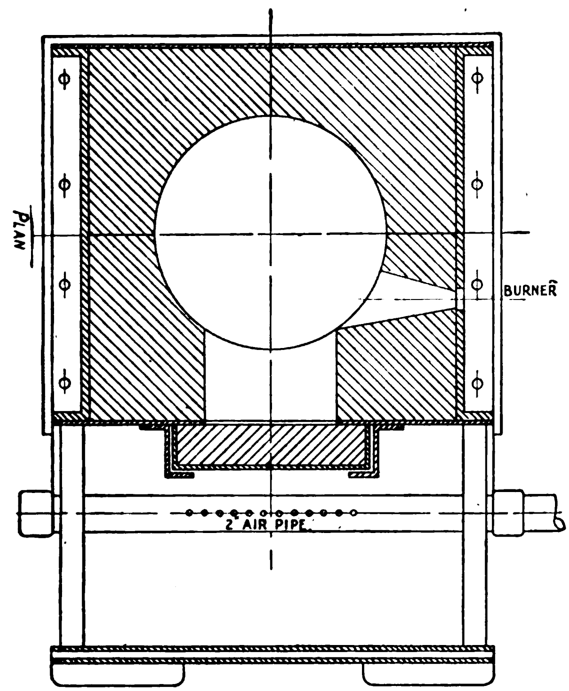

FIG. 4.—SECTIONAL VIEW OF "ROTOFLAM" TOOL-HARDENING FURNACE (Thompson's Patent).

any required metallurgical conditions can be secured with a minimum of adjustment.

Still proving the point of the elimination of waste, I take as another example the hardening of high-speed steel cutters, tools, etc. This is a highly skilled operation, and one in which expensive losses can easily occur, the cost of the articles treated often running into many pounds each. You will be interested in quite a new and improved type of furnace, as seen in the sectional drawings (Figs. 4 and 5). It is known as the "Rotoflam" (Thompson's patent). The furnace chamber is circular, and is heated by gas and air blast burners, two of which are used — one at the top and one at the bottom of the chamber, and equidistant on the circumference. The flame from the burners encircles the inside walls of the chamber, and generates a heat suitable for any class of high-speed steel. The point I particularly wish to emphasise is that there is no direct flame contact, all the heating being by radiation. Therefore there is no excessive heat at one point, and a gradual soaking heat is ensured. The most delicate articles may be treated within the finest limits of temperature without fear of burning. There is no flue or chimney in this furnace, the exhaust gases being expelled automatically through the mouth, thus preventing any free air from outside entering the chamber and oxidising the steel. It will be realised how completely this well-designed furnace eliminates the possibility of spoilt work.

The next slide shows a fine installation of a somewhat different type of high-speed steel furnace — viz., the Brayshaw. These are very well known and largely used in the steel industry, and produce remarkably good and consistent results.

The upper chamber is heated by waste heat from the lower, and serves for pre-heating tools, etc., before they are put into the lower furnace, raising them gradually to a medium temperature preparatory to the final quick-heating required to bring them up to the high

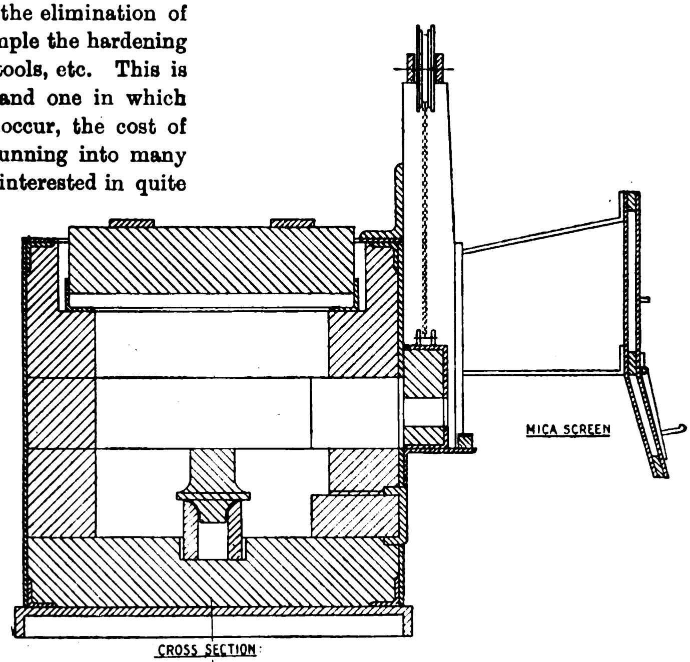

FIG. 5.—SECTIONAL VIEW OF "ROTOFLAM" TOOL-HARDENING FURNACE (Thompson's Patent).

temperature necessary for hardening. By means of this furnace the skilled operator is enabled to ensure the production of good tools giving the maximum of service, and to avoid the waste of expensive material and time due to under-heating or over-heating in hardening, etc.

I think I have demonstrated—I hope to your satisfaction—how gas can help in eliminating waste in processes of manufacture in vital industries, and by this positive reduction of waste materially assists in increasing production. I will now turn to the equally important subject of

A. *Capital Outlay.*—Where gas is employed, the building of a smoke-stack is not required. Gas furnaces do not involve any structural alterations to the factory, nor special foundations; while their initial cost is in many cases lower than solid-fuel furnaces. The fuel has only to be paid for as it is used; and there is no big stock of fuel to be stored, with consequent interest on the capital outlay.

B. *Labour.*—To-day labour has (so to speak) a capital cost exceeding anything that has obtained in the past; and this fact must also alter our point of view when considering reduction of

FIG. 6.—A TYPICAL HEAT-TREATMENT SHOP, SHOWING RICHMOND'S OVEN FURNACES.

2. THE CHEAPENING OF PRODUCTION.

To lower the cost of his finished product must be the constant study of every manufacturer, as we realise that high prices mean less purchasing power, and less volume of output. Gas places us all under a debt for the service it renders in cheapening production. A glance at the neat, compact, self-contained gas furnaces seen in the shop on the screen (Fig. 6) convinces one on this point. The economy that issues from the use of gas may be detailed under four heads.

costs in relation to increased production. With gas, no stoking or clinkering or removal of ashes is required; and labour—highly-paid labour to-day—is saved. No labour or cartage has to be expended in transporting fuel—a further considerable saving. The choice for the position of the gas furnace is practically unlimited. It can be brought into proximity to the machine worker, and thus intermediate handling is saved. For example, the furnace (shown on our next slide) is used close up to the hammer, and so dispenses with considerable

labour. This particular furnace is heating brass discs 3 in. in diameter by $\frac{3}{8}$ in. thick at the rate of six per minute.

C. *Cost of Fuel.*—The use of gas renders unnecessary storage accommodation for fuel. Coal and coke stocks require valuable space, and incur rent without directly earning anything for the area occupied. In the running cost of fuel I have two examples to touch upon briefly—both from a large engineering centre in the north—comparing first the cost of gas with oil, and then with coke. The first processes are the heating of spring buckles prior to pressing on to the spring, and the heating of round longitudinal stay-rod ends for locomotive boilers before "heading." The gas furnace used for this work is illustrated on the screen; and the cost of gas consumption is 1*s.* 3*d.* per hour, as against 3*s.* 1½*d.* per hour with the oil furnace it displaced, and as prices were on the rise the comparative difference is actually greater than these figures represent.

This same industrial area specialises in the manufacture of colliery tipping tubs; one of the requisites for this work being the regular provision of ½-inch rivets. Gas is proved to be ideal for this process, giving a constant supply, unvarying in quantity and quality, hour by hour, and keeping pace with the demands of the riveters. Gas performs the work, too, at a minimum of cost for fuel;

PERCENTAGE RISE IN COST OF RAW MATERIALS ETC.

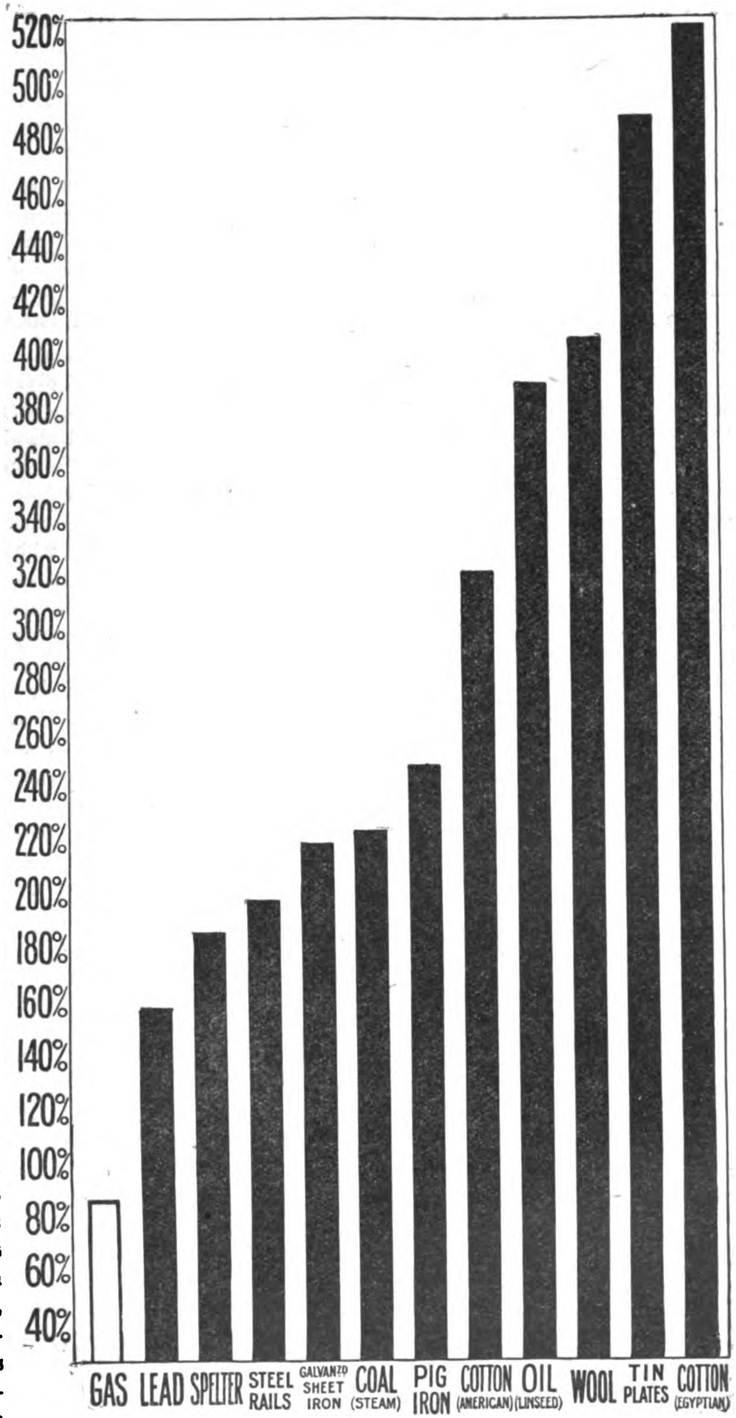

FIG. 7.

the figure being 2s. 9½d. per 8-hour day, against 5s. 7d. per day for coke for the same output. Those are tangible differences which need no comment.

It will be opportune here to refer to the price of gas. I have prepared the chart which forms our next slide, showing that the price of this commodity has increased since July, 1914, by a very much lower percentage than raw materials, &c. (Fig. 7). The price of gas has made a contribution to the increased costs of manufacture to a very much smaller extent than all other commodities, and is to-day comparatively the cheapest of the factors that make up the cost of the finished product. The percentage increase in the price of gas—viz., 80 per cent.—is based on the pre-war prices compared with the prices on December 31st last of all gas undertakings in the United Kingdom making over 300 million cubic feet per annum.

D. *Factory Floor Space.*—Lastly, the gas furnace, self-contained and compact as before mentioned, economises that very valuable asset —factory floor space. This provides the means for an increase in output per unit of factory area, without any corresponding increase in overhead charges—indeed, obviously without any increase at all in rent, rates, etc. This economy is pictorially shown in the next slide. It will be noticed that three gas furnaces (the correct dimensions of which have been outlined) only occupy the same space as one of the coal-fire variety, with its indispensable coal-storage space, which, as previously remarked, is not called for with gas. As each of the gas furnaces has precisely the same oven dimensions as the coal-fired one, this at once increases the output threefold for the same floor space.

From these facts it will be apparent to what a large extent gas can claim to reduce the cost of the finished article. There is a saving in capital outlay, in labour, in fuel, and in factory space, all of which react on the cost, and consequently on the selling price and the output.

Having now dealt, first, with the manner in which waste and rejects are eliminated, and second and more briefly with the reduction in the cost of production, I wish now to show how the actual output of the product is "speeded-up" by the aid of gas.

3. The "Speeding-up."

It will be apparent that the sections into which I have divided this paper necessarily slightly overlap, and that some of the points I have already dealt with in Sections 1 and 2 have their direct effect on output. I do not think I can better illustrate my point of "Speeding-up" output than by giving some general particulars and examples which have come under my personal notice.

The first slide in this section shows a battery of gas furnaces which superseded coal furnaces for annealing purposes. The results of this change were really extraordinary. It was found that the gas-fired oven (of the same size as the coal furnace) could take a load 33⅓ per cent. greater than the coal-fired, owing to its construction and uniformity of temperature. In the deposed furnaces, owing to the "cold mouth," the load could not be placed within 18 inches of the door. Further, in the case of gas, the time the articles were in the furnace was reduced by 33⅓ per cent. This, as you will see at once, doubled the output per furnace, or, conversely, halved the time per unit of output.

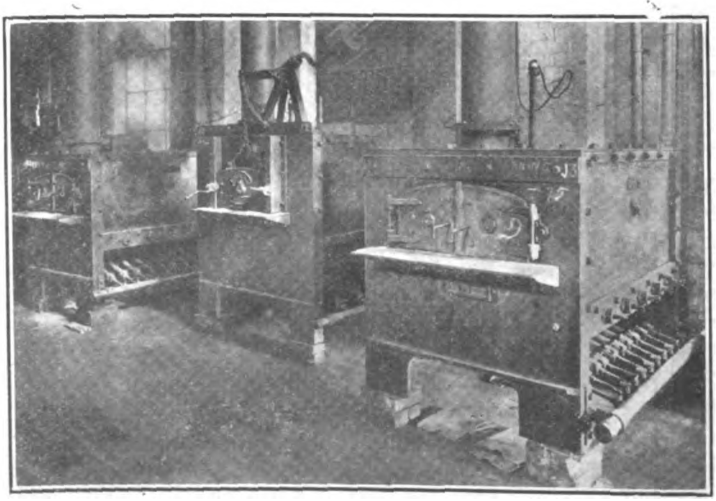

Fig. 8.—Natural Draught Gas-heated Furnaces for Annealing.

Let us take as another example an annealing process, as performed in the installation now before you on t e screen (Fig. 8). This is a case in which fairly bulky articles had to be heated, in large numbers, at a fixed temperature, with a limit allowance of a very few degrees up or down. To execute the desired quantities, it was

necessary to fill the furnace completely at each charge. The articles were stacked on racks or trays, and these furnaces filled from the end to the mouth, so that the door could just be closed. Upon the completion of the heating period, every one was perfectly annealed, and tests made on those taken from the sides, middle, or ends showed no variation, and all equally passed the stringent conditions enforced. Had there been any variation in the temperature over the oven, those unequally heated would have been rejected, would have had to pass back for re-treatment, would have lowered the output, and thrown out of gear all the fine organisation of the works that was based on the speedy and continuous passing of the article from one class of operation to the next.

This leads me to another point—viz., that, by the constancy of action of the gas furnace, the time required for the heating operation is definitely ascertained, the work comes through at a uniform speed, and the works manager can safely organise his other departments without any uncertainty as to his supply of heat-treated materials. The furnaces in the next picture are engaged on an annealing process that is timed to take thirty minutes for actual heating. Allow five minutes for charging and five minutes for unloading, and the works manager knows that every forty minutes each furnace will give a definite output—not perhaps, not sometimes, not dependent on the human element, not varied by any external circumstances, but always and all day. This is a striking example of the service which gas renders. The next slide is a reproduction of a sheet taken from a recording pyrometer, and it indicates at a glance the regularity with which the desired temperatures were obtained for successive charges in a gas furnace, emphasising the illustration I have just given.

My next slide shows a sectional view of a "L.P.G.A." (low-pressure gas and air) Furnace (Richmond's patent), and as I have some very convincing figures to give of the working of this type of furnace, it will not be out of place to spend a minute or two in describing the principle of working. It will be observed that it is "over-fired"—*i.e.* the gas supply at normal town's pressure is led through ports at one or both sides, where it comes into contact with the air (supplied at approximately 2-in. water-gauge) obtained from a small fan, which air has been previously well pre-heated by being taken through the opposite side of the furnace in fire-clay tubes and then passed along the bottom of the furnace in close proximity to the hot waste products. Combustion takes place inside the working chamber round the furnace walls, the usual separate combustion chamber being absent. The flames produced keep well up and sweep round the arch. The products of combustion then pass to the opposite side of the furnace, are carried under the floor and up the other side away to the flue. All the waste heat possible is utilised in pre-heating the air, and this promotes economy and efficiency.

The flues are required simply to convey away the products of combustion (not to create a draught), and adjustable dampers are provided, so that there is no actual pull from the furnace chamber to the outside air. With pressure inside the furnace, air cannot enter through the door or any other orifices even when the former is opened for any purpose.

To come now to the actual performance of this furnace, I have been furnished with figures, which are strictly comparative, showing its superiority over a certain installation of solid-fuel fired furnaces in an important engineering industry. The operation is the normalising of a certain small article which is hammered out of mild steel wire. Owing to the necessity for absolute accuracy and dead even heating the solid-fuel furnaces were condemned and replaced by others fired by gas, with the result that not only was the heating process rendered absolutely satisfactory, but the output was increased to an astonishing extent. There were formerly four solid fuel furnaces, each measuring 6 ft. 9 in. long × 3 ft. wide × 1 ft. 9 in. high; and at each charge 6,000 articles could be treated—two charges per day being secured, or an output of 12,000 articles. The four "L.P.G.A." furnaces (of precisely the same internal dimensions) which were substituted for the coke furnaces took a charge of 10,000 articles instead of 6,000, and four charges per day were secured against two; thus making a total output for the day of 40,000 articles, as against 12,000 with the coke furnaces, or an increase of 233 per cent.

Further, this increase was obtained with actually a proportionately reduced cost for fuel; the gas consumption per charge costing 12*s.* 10½*d.* (with gas at 3*s.* 7*d.* per 1,000 cubic feet, which is a fairly high rate for industrial purposes), as against 13*s.* 1½*d.* per charge per furnace with coke. As the gas furnace took a charge 66 per cent. greater, the actual cost for fuel was 70 per cent. more with coke. I have

not been able to obtain a photograph of the actual installation just described, but the next picture shows us one of the same type of furnaces. The one seen (Fig. 9) is used for

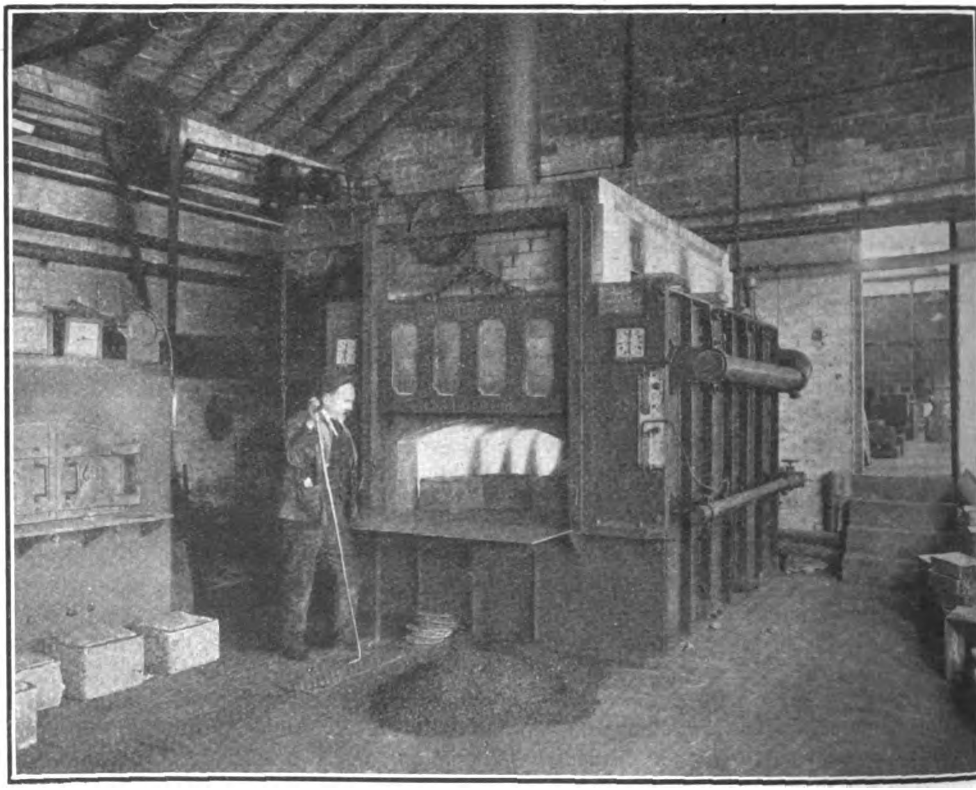

FIG. 9.—RICHMOND'S PATENT SOLID FLOOR "L.P.G.A." OVEN FURNACES FOR CARBURISING 12-CWT. LOADS AT ONE CHARGE.

carburising. The weight of a full charge of the parts to be treated is 12 cwt., and the operation carried out at 920° to 940° C.

The users have provided me from their experience with two very strong points in favour of the gas-fired appliance, in addition to the increased output, viz., that the life of the carburising pots which are used in this process, whatever fuel may be used, has been increased by 50 per cent. by the use of gas, and that the cost of furnace repairs and replacements has been enormously cut down—in fact, the furnace seen on the screen has been running *daily* for nine months (the capacity for continuous work is a most important matter in works production), and has not yet cost a penny in any way for maintenance.

As another example of the speeding-up of output procured by the use of gas, I am able to give very complete results of actual working practice with a Davis' patent "Revergen" furnace, as compared with the coal-fired furnace which it supplanted. The principle of the "Revergen" furnace, as shown on the screen (Fig. 10) may be briefly stated to consist of a system of gas-firing by means of which heat losses, by way of furnace flue or flues, are reduced to an insignificant minimum; and the thermal energy thus recovered is utilised almost exclusively for the practical purposes of the furnace. The particular furnace in question was used for heating heavy forgings at a marine engine works; and I may state that the figures (see p. 357) both for gas and coal were provided by the users, the tests being made by them under ordinary working conditions.

It will be seen that the net output was over 10 per cent. higher, while the net cost of fuel and labour was reduced by over 51 per cent.

Incidentally these figures provide a very interesting illustration of another point, viz., the conservation of coal effected by the use of gas. It will be observed that in the coal furnace 55 cwts. of coal were completely destroyed per

Coal v. Gas for Forging.

One Week's Work with Coal.

Forgings produced, net = 65 cwts.

Costs:	£	s.	d.
9 tons of coal at 39*s*. per ton . . .	17	11	0
Firing, 18 hours at 1*s*. 1*d*.	0	19	6
Carrying coal, 24 hours at 1*s*. 6*d*. . .	1	16	0
	20	6	6

Cost per ton, net . . . . £6 5*s*. 1*d*.
Coal per ton, net . . . . 55·38 cwts.

Weekly Cost with Gas.
(Average of five weeks' working.)

Forgings produced, net = 72 cwts.

Costs:	£	s.	d.
50,250 cubic feet of gas at 3*s*. 9*d*. per 1,000 cubic feet	9	8	6
1 man, 7 hours at 1*s*. 6*d*.	0	10	6
	9	19	0

Cost per ton, net . . . . . . £3 0*s*. 6*d*.
Gas per ton, net . . . . . 15,055 cubic feet.

Output increased by = 10·76 per cent.
Cost per ton of forgings, reduced by = 51·6 per cent.
Percentage of virgin coal saved = 80 per cent.

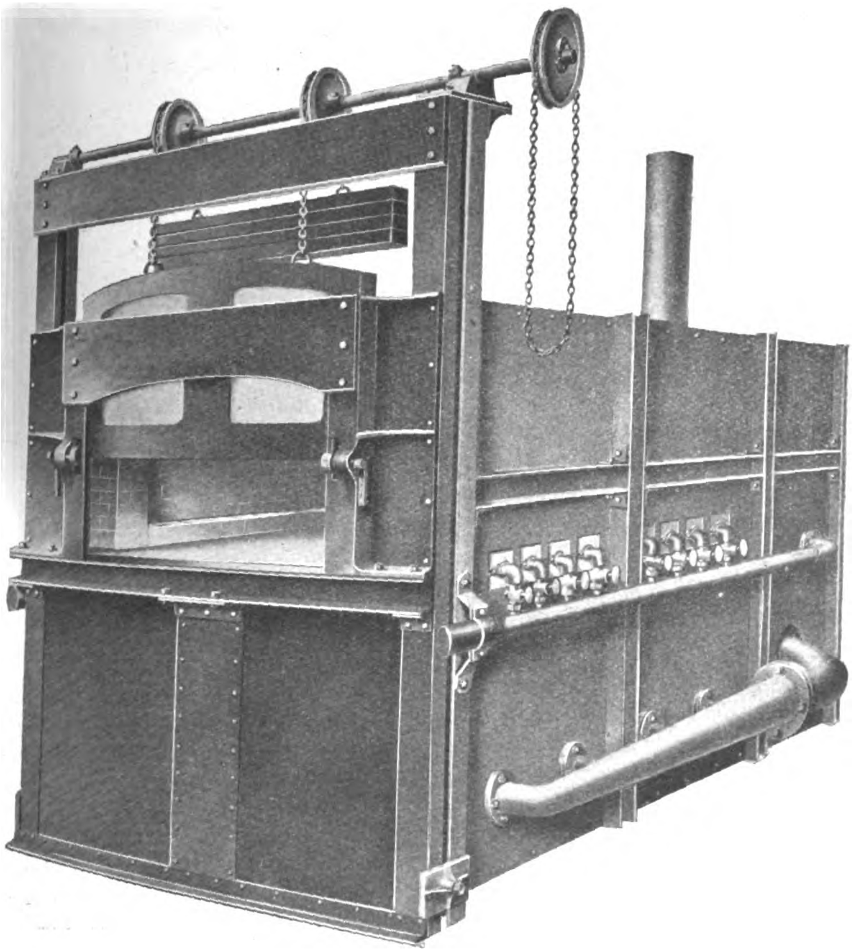

Fig. 10.—The "Revergen" Oven Furnaces (Davis Furnace Co.'s Patent).

ton of forgings. In the gas furnace 15,055 cubic feet of gas were used per ton of forgings. Now, assuming the gas works produces and sells 12,500 cubic feet of gas per ton of coal carbonised—many are, I ought to say, doing much better than this where there has been the opportunity of adopting the more modern gas-making process—each ton of forgings entails the carbonisation of only 1 ton 4 cwt. of coal, as against the 2 tons 15 cwts. directly used and

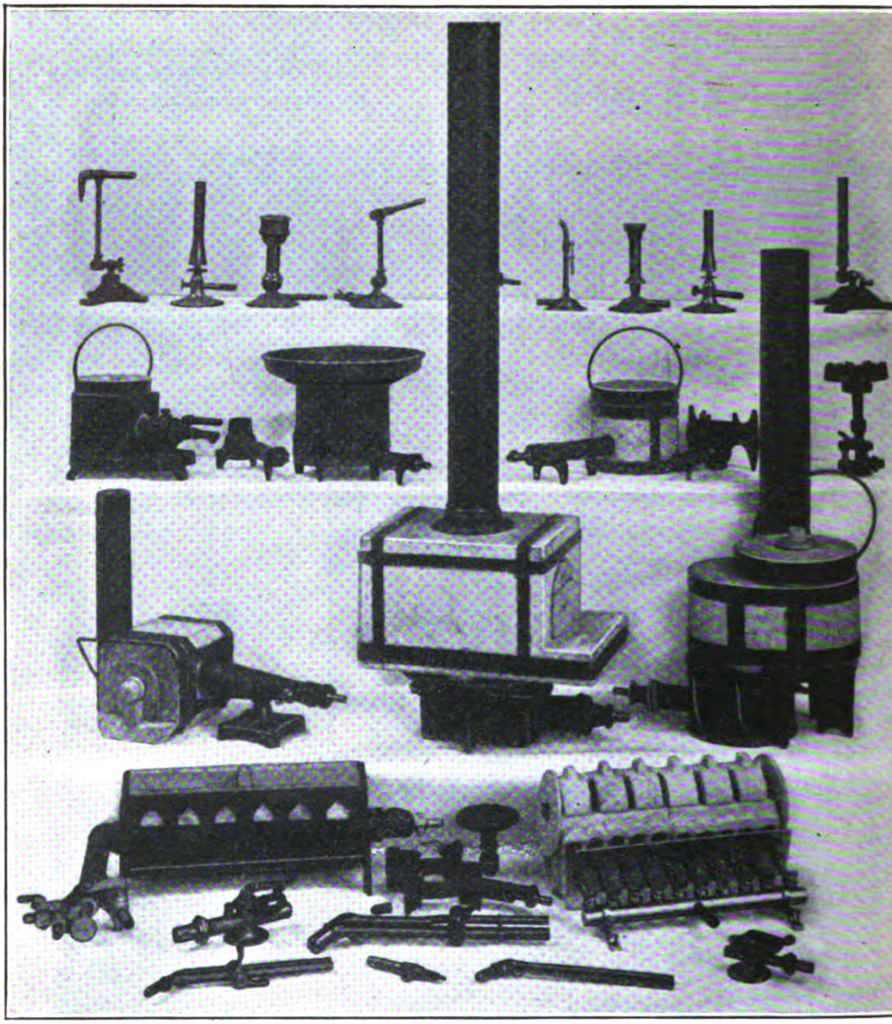

FIG. 11.—GAS-HEATED LABORATORY APPLIANCES (Fletcher, Russell & Co., Ltd.).

completely destroyed by the coal furnace; thus directly saving 1 ton 11 cwts. of virgin coal, plus 12 cwts. of coke rendered available for sale, a total saving of 43 cwts. out of 55 cwts.

Further, after the gas works has carbonised the coal, there are the valuable secondary by-products still left available for use, namely, tar, sulphate of ammonia, and a variety of valuable derivates from both the gas and tar. This demonstrates in a very forceful manner the national importance of an extended use of gas, a subject to which I shall refer again in a few minutes. Another example of an industry which has recently found the advantage of gas for increased output is that of the annealing of grey iron castings; and the following examples will be of great interest to those engaged in this work. The process consists of packing these castings into iron pots, surrounded by a suitable inert material, such as sand, bringing to a temperature of 820° C., and maintaining it throughout for a period of three hours. The total gross weight of eight charges was 11,753 lb. The gas consumption per lb. of gross load was 1·89 cubic feet and 3·9 cubic feet per lb. of castings. These figures are, I am sure you will agree, very convincing testimony to the use of gas for this work.

Our next slide (Fig. 11) shows a group of gas-heated laboratory appliances (by Messrs. Fletcher, Russell and Co., Ltd.). I should perhaps have referred to this earlier in the paper, in view of the extent to which the efficiency, economy, and consequently output of modern

factories depend on laboratory work and the researches of the works' chemist. Gas for experiments and investigation is, of course, not a new development. But appliances have been perfected, and fresh ones introduced; and the comprehensive series seen on the screen shows the wide use of our commodity for this highly important work.

My next example of increased output as a result of gas installation deals with metal-melting. No furnace has made as a commercial proposition greater progress in the last few years than the gas-fired crucible furnace. It is not only now possible to use gas efficiently for this purpose in that it bears favourable comparison with solid fuel, but it shows many substantial advantages over its earlier rival. One of the most exhaustive comparative tests made of the capabilities of coke and gas for melting was by Mr. G. B. Brook at the Sheffield University, who reported the result in a paper before the Institute of Metals in 1917. The gas furnace used was of the standard pit type as seen on the screen.

"In order to make the test as drastic as possible, cupronickel (80 : 20) was chosen as the test alloy, in view of the high temperature required for this particular material. Every endeavour was made to ensure that the work should be on as large a scale as possible, closely following commercial practice, so that the results obtained would be accepted by manufacturers as a guide to what might be expected in their own melting-shops. During the ten working days covering the period of the test, the total weight of metal that went through the furnace was 51 cwts." The results proved conclusively that gas for melting metal is satisfactory from every point of view. The necessary high temperature of 1,400° C. was readily obtained; and the average time of the 56 lb. load in the gas furnace was 52 minutes, against 82 minutes with the coke furnace. It was found possible on two of the days out of the ten to secure twelve heats with the gas furnace in less than ten hours, as against the usual practice of five heats with the coke furnace. The average life of the crucible was longer in the gas furnace; and the lining of the furnace stood the test satisfactorily. The mechanical losses in charging and drawing were less than ½ per cent.; the best practice with coke being 1 per cent. The quality of the metal produced was everything that could be desired.

On the questions of labour charges and cost of fuel, Mr. Brook's results are of great interest. He says: "On a large installation there would be a distinct advantage in favour of gas in the amount of labour required. Four coke-fired furnaces can be worked by three men. It would be possible to work a six-hole gas-fired battery with four men, even taking into account the extra mould preparation incident on the increased speed of gas-melting." In regard to consumption of fuel, the cost per ton of metal melted was 31*s*. 9*d*. and 36*s*. 4*d*. for gas and coke respectively. The prices of gas have risen since this test, but so have the prices of coke.

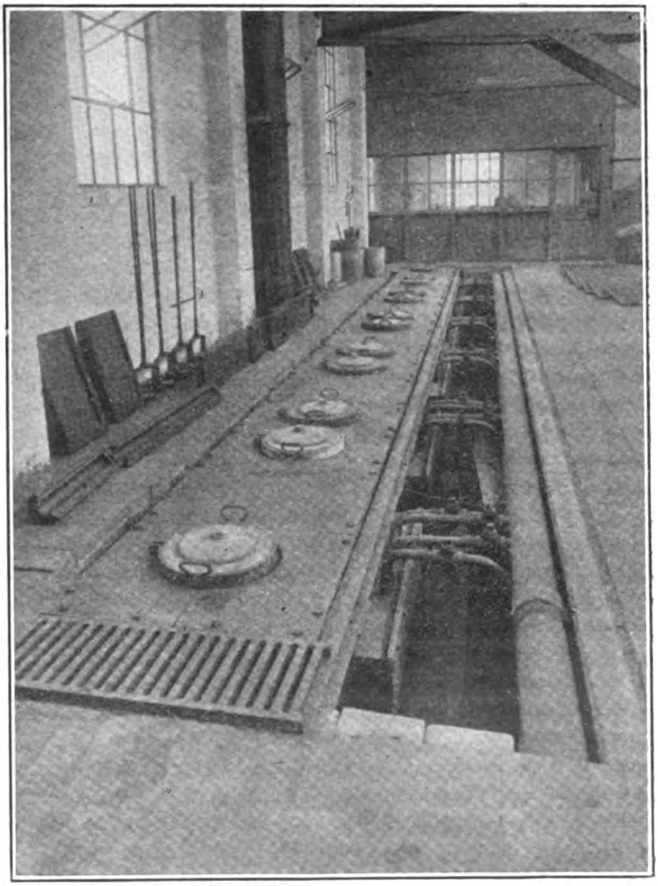

Fig. 12.—Twelve Pit-type Richmond's Crucible Furnaces.

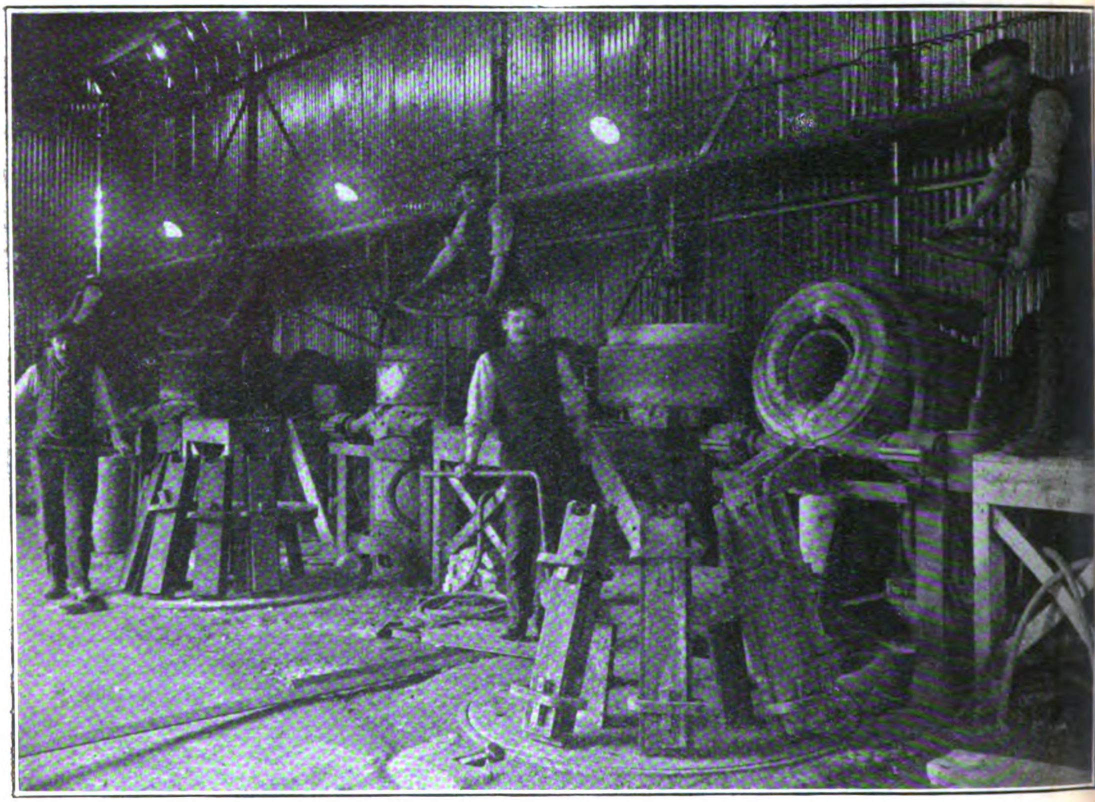

FIG. 13.—BATTERY OF "LIP-AXIS" TILTING CRUCIBLE FURNACES (John Wright & Co.'s Patent).

These figures were strikingly confirmed at a meeting of the Institute of Metals in a paper read by Mr. W. J. Hocking on metal-melting as practised at the Royal Mint. He gave results of five years' working with both gas and solid fuel; and it was found that the gas furnaces gave an increased output, for gold, of 88 per cent., up to, for cupronickel, 161 per cent. The average cost of fuel and crucibles over five years was £3 1*s.* 2*d.* in the case of coke, and £2 7*s.* 5*d.* with gas, per ton of metal melted. The number of men employed was actually 19 per cent. less with gas than with coke for the same output. This convincingly shows the saving of time, labour and material resulting in the larger output by the aid of gas.

The next slide shows us a fine row of pit-type furnaces (Fig. 12), installed for the purpose of melting a special alloy. Founders who have had similar furnaces in use for three years say they are still "perfectly satisfied. Two tons of metal were melted per week, 11 melts being carried out per 8½-hour day. The cost of renewals has been confined to replacing the top lids after the first ten months' use." This is convincing testimony to the commercial use of gas for melting. The next picture is of the furnace itself. In this type the air for combustion is pre-heated as well as the metal, and this accounts to some extent for its high efficiency and large output.

When large quantities of metal are to be melted, the furnace usually employed is of the Lip-Axis Tilting type (made by John Wright and Co.), as seen on the screen (Fig. 13). These furnaces, with crucibles up to 600 lb. brass capacity, work with incredibly low gas consumption. The next picture shows us a battery of these large furnaces.

An installation of furnaces of these big dimensions is an outstanding tribute to the progress made and the stage of perfection reached in the utilisation of gas. As Sir Robert Hadfield remarked on the occasion of my last paper, it would have been deemed incredible a few years ago that gas could be economically used for such large industrial work.

Instances such as I have given could be multiplied in all trades, but I think sufficient

evidence even from the comparatively small number of examples dealt with has been adduced to prove the value of gas in relation to increased production and output.

4. THE HUMAN ELEMENT.

One other matter (and that of considerable moment) remains to be mentioned in the short time I have at my disposal, viz., the human element in the factory — the worker. Mr. Hoover, the American statesman, recently advised Europe to "work harder." One phrase in his statement was "Many people in Europe are not at work." Now we are sure that Mr. Hoover did not forget, although he did not mention it, that the working power of Europe has been very seriously reduced by the loss of many efficient producers, and those the most vigorous of our manhood. As Great Britain lost 800,000 killed in the war, it would be a reasonable figure to assume, allowing for wounded and diseased, whose physical strength has suffered considerably, that we are poorer by the loss of a million and a half of workers. This is a very substantial reduction in our army of producers, and it is clear that, without other aids, and without greater organisation, the same output as before cannot be expected. This fact must be recognised in all our comparative statistics of total production. It points emphatically to the need for the use of every appliance that can assist the human factor in industry.

Mechanical aids, scientific management, modern machinery, a higher standard of health and efficiency, greater skill and knowledge, more extensive training and practical research work, must all be called in to the help of the worker and the improvement of the industrial output. I have already shown how gas can help in some of these things; and in concluding this section of my paper I want to present a few of the ways in which that servant of the nation assists in improving working conditions for the men and women in our factories. A better standard of living is called for—and rightly called for—and there is, in my view, much opportunity for ameliorating the conditions during the working hours, with far-reaching results. The strain will be less exacting, health will improve, efficiency will rise, production will grow, and greater prosperity for all will follow in a natural sequence. I do not claim—I could not attempt to do so—that gas by itself can solve all these problems. But it has its contribution to offer; and it waits to join many other agents in taking a step forward in these matters. For example, take the furnace which is used for the heat treatment of high-speed steel shown on our next slide (Fig. 14). In its construction the comfort of the workman has been considered in every possible particular. Observe the pipe mounted in front and directly below the mouth of the furnace. This is drilled with a series of holes through which a stream of

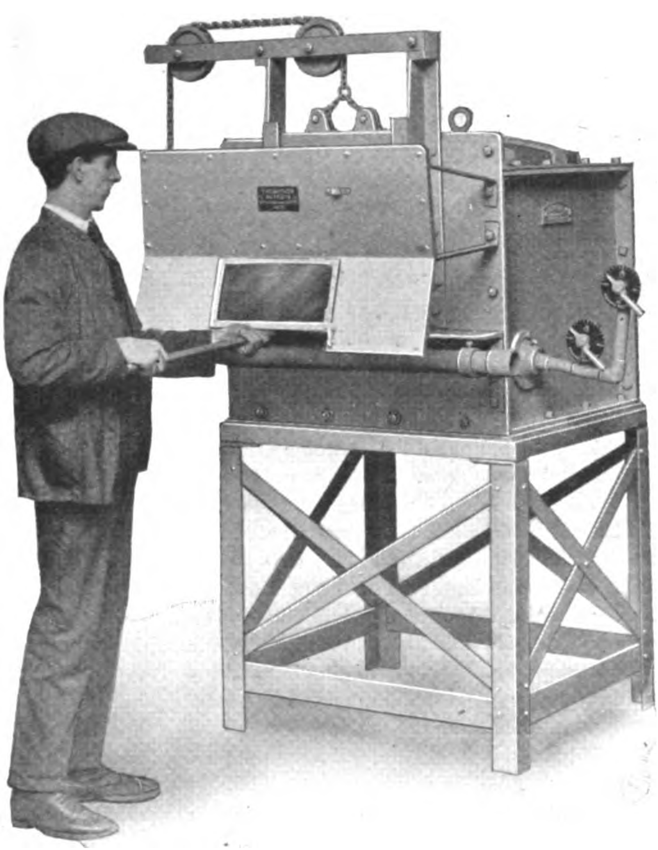

FIG. 14.—GAS AND AIR BLAST "ROTOFLAM" FURNACE (Thompson's Patent) FOR HARDENING EXPENSIVE HIGH-SPEED STEEL TOOLS.

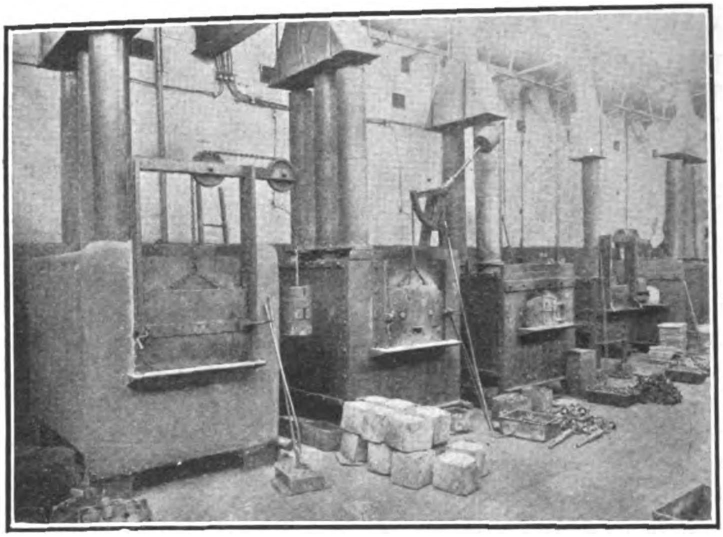

FIG. 15.—MODERN HEAT-TREATMENT SHOP EQUIPPED THROUGHOUT WITH GAS FURNACES.

air, delivered under pressure, forces the exhaust gases upwards and away from the operator, and at the same time keeps cool the tongs or the shank of the tool for ease in handling. As an additional protection an asbestos-packed guard, with hinged mica screen, is provided. No heat is radiated on to the operator as in the case of a swing-out door. These are all small matters, but it needs little imagination to conceive how much they add to the ease of operation, save the worker from discomfort, and enable him to maintain a high rate of output throughout the whole of the day. Again, look at the up-to-date heat-treatment shop which forms our next picture (Fig. 15). Even in this reproduction the air of cleanliness and lightness is apparent. The men themselves are ready to acknowledge the benefits derived from the gas-fired appliance.

The following is a sample of several similar reports that have reached me.

"When gas was being installed much opposition was shown by the men. They were conservative, as many workmen are, and were sure the furnace would not do the work. Now, after experience, I believe they would soon strike if it were ever suggested to go back to the old methods. They appreciate the greater efficiency, the cleanliness, and the labour-saving attributes of the gas-fired furnace."

Here is another (a cutting from a recent technical journal) describing a new installation of gas furnaces: "The workmen say that the conditions of labour are much better than in the old days. The plant is easier to control, cleaner to work, and the necessity to draw fires has been done away with."

Closely allied to, and indeed a natural corollary of the subject of improved workshop conditions and their effect on production, is that of general welfare work throughout the factory. I devoted a considerable portion of my paper in April, 1917, to this topic, and I will therefore only briefly touch upon it this time. It has, however, a direct and vital relation to the subject of increased production under consideration this afternoon. During the war "welfare work" received a remarkable impetus, and marked success attended its expansion. The form that this most frequently took — although in many factories this new principle in industry was developed to a very considerable extent — was the industrial canteen or works' dining-room, an example of which is seen on the screen. The results secured by, and the advantages accruing from, the establishment of these canteens have been very impressive. There has been a marked improvement in the health of the workers, with less sickness, and less absence and lost time; and a less tendency to alcoholism has been observed, all making for increased efficiency and larger output. Further, the substantial, nourishing, and reasonably priced meals provided by a canteen situated in the works have saved the time of the worker, given him a salutary mid-day change from the workshop, enabled the shop to be properly ventilated in the complete absence of the workers, and generally created an atmosphere of greater contentment and goodwill. These are solid and substantial advantages, and their effects on output are testified to from all quarters. This is undoubtedly a movement that possesses great possibilities for the future, and it is to be hoped that in all reconstruction proposals room will be found for this very helpful adjunct to factory life. It will be a great disappointment if the progress made in this

direction is not maintained, and very greatly extended, under peace-time conditions.

Gas is, of course, the chief fuel used in these canteens, and I show just one picture of a modern kitchen equipped throughout with gas apparatus (Fig. 16). The reasons for the choice of this fuel are fairly well known and obvious, and so I will not stop to discuss them again. I will, however, remind you that it received official sanction and encouragement, for the Committee on the Health of Munition Workers reported: "Gas cooking is usually preferred on account of cleanliness, efficiency, and saving of labour." Quite recently the National Kitchens Division of the Ministry of Food testified to the suitability of gas for the cooking of food for large numbers in the following words: "The National Kitchens Division has had extended experience of cooking appliances, and still advises the use of steam, when available, for heavy duty such as boiling pans. The Division's experience of electricity for cooking has been anything but favourable. Gas appliances are more constantly reliable, and much cheaper to install and maintain, and they consume less fuel."

We have now considered the worker during his labouring hours. But this section of my paper—the human element—would not be complete without a reference to the domestic side of his life—that is, to the home. The conditions there must directly and indirectly affect his health, his efficiency, and his ability to perform his daily work. This subject, however, requires an afternoon to itself, and I can only briefly refer to it now. The claims of gas for domestic purposes are so indisputable that its sway has become well-nigh universal. It is recognised that in the new housing schemes gas will play a leading part, as it provides the means whereby unnecessary labour is eliminated, economy is obtained, cleanliness and hygiene are assured, and the comfort of the worker, his wife, and his family is secured. Gas is an essential corollary to the raising of the standard of living, which we hope will ultimately lead to a ore efficient worker, and conequently a higher output. Incidentally, gas can, and will, aid materially in expediting and cheapening the actual building of the new houses for which the nation anxiously waits. Gas fires for rooms requiring intermittent heating, such as parlour and bedrooms, should be the accepted policy, and I am glad to learn this is recognised by the Ministry of Health. The use of the gas fire abolishes chimney-breasts and the large smoke-stacks necessary to carry off the products of combustion from coal fires. A glance at the two plans (prepared by the Nautilus Fire Company) now on the screen show clearly the saving in space and economy in building effected by the substitution of gas fires in place of coal. By installing specially-designed gas-flues (Fig. 17) in place of the ordinary 9-in. by 9-in. coal-flue the cost is reduced considerably, as they eliminate brick chimney-breasts, brick footings, foundation concrete, skew-back arches, trimmers, chimney-stacks, and, at the same time, reduce the amount of leadwork required in soakers, flashings, aprons, etc. After most careful estimates, it has been found that the net saving is £30 per cottage, after allowing ample for the provision of gas fires and gas supplies. On the 500,000 houses which were originally contemplated (the number is much greater now) the saving would amount to £15,000,000. Another important factor must be mentioned. By eliminating the chimney-breast additional floor-space of about 120 feet super is obtained and an increased cubical capacity of over 2,000 cubic feet per block of four cottages.

Fig. 16.—Gas-cooking Equipment in the Kitchen of the Bank of England.

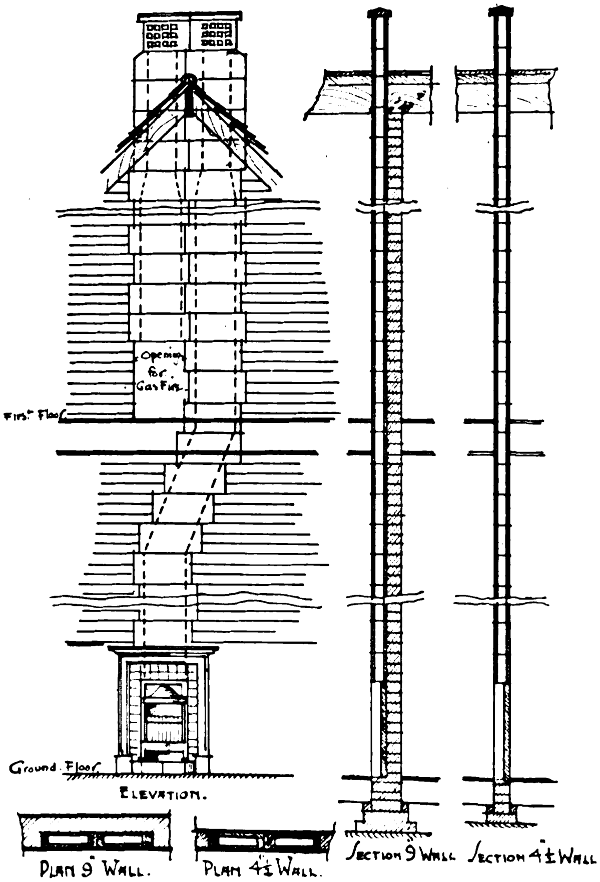

FIG. 17.—DETAILS OF CAST CONCRETE GAS FLUES AND TERMINALS (Nautilus Fire Co.'s Patent).

I have tried to show how gas eliminates waste in manufacturing processes, how it cheapens production, how it "speeds-up" output, and how it adds to the personal comfort and well-being, and thereby the efficiency of the individual. There are, however, other considerations which should not be left out. Our story does not end with the industrial benefit obtained by the use of gas, for it is the carbonisation of coal at the gas works that liberates the multitudinous and valuable by-products. It is surprising how little the public generally realise the need of eliminating, as far as possible, the wasteful method of consuming coal in its raw state, which, apart from its inefficiency, involves the absolute and entire loss of these by-products. This subject is entirely appropriate to our topic this afternoon, as the nation, in these difficult days, cannot tolerate loss in any form. It is not, too, as though we were losing something of little or no productive value. Take, for instance, sulphate of ammonia. This excellent fertiliser is of the greatest worth to our agricultural community in the endeavour to produce more. There is an eager market for it abroad, and the national position demands that our export trade shall be swelled to its fullest limits. Then there is benzol, a highly efficient, home-produced motor spirit, that saves the import of petrol, and assists in solving the great transport question which is of vital importance to the improvement of production. At present only about 14 per cent. of our coal is carbonised, and benzol extracted. Again, decrease in the use of coal in its raw state, and an increase in the quantity carbonised, would provide us with more heavy oil for generating power to drive our naval and merchant ships, and save importation. Then consider the dye industry, for the products of which we have been very largely, and all too long, dependent on other countries. The distillation of coal tar gives us the materials for the quantities of dyes we need. The "key" industry must be fostered. Then, of course, there is the gas coke, of great value as a cleanly, efficient, and smokeless fuel, suitable for domestic and many factory uses, especially for steam-raising. We have seen lately how large economies have been effected at the East Greenwich Electric Power Station of the London County Council by using coke and coal under the boiler on the "Sandwich" system; and in the latest installation at the Manchester Corporation Electricity Works the same system has been adopted. Apart from the direct money economy, a high evaporative duty is secured, by the intensity of the combustion of the fuel due to the porosity given to the bed by the use of coke.

In our striving after greater production and national economy, it is essential that the facts I have stated should take a foremost place. Our prosperity has been founded on an ample supply of cheap, readily available coal; but we have been too prodigal in its use. The most economical expenditure of our stock as yet unmined is a matter of vital national concern. If Great Britain ever has to begin to import coal, then, in the words of Lord Moulton, "the end of our industrial and commercial greatness

will not be far distant." We must cease the waste of coal, and learn to use it wisely and well. Every smoking chimney, domestic or factory, spells waste of coal, and the dissipation of those chemical by-products the recovery of which would be of such inestimable gain to the nation. In addition, every smoking chimney pouring forth its wasted energy, pollutes the atmosphere, obstructs the sunshine, poisons our lungs, and lowers our physical fitness. Destruction is the antithesis of production, and any effort that can abate the smoke nuisance will be a direct contribution to our national effort to improve our economic position. This is not a matter of minor importance, or a side issue. Our large cities pay a heavy tribute year by year through the continuance of this evil. After the most exhaustive investigations, Manchester has come to the conclusion that the damage wrought by smoke, and the increased cost incurred owing to its unwelcome presence, is at least £1 per head per annum, or £750,000 for the city. The national case for the extended use of gas is overwhelming. The commodity we are considering this afternoon has played a great part in the life of this country, and is destined to take a still more prominent place in the future. Gas manufacturing is one of our greatest industries; no industry has ever been developed which has been of more service to the community. Quoting from figures presented lately by Mr. D. Milne Watson, the Governor at the Gas Light and Coke Co., to the Board of Trade, it has 150 millions of capital invested in it; it employs some 100,000 workers; there are 1,600 gas undertakings. It uses 20 million tons of coal yearly, and some 50 million gallons of gas oil. There are over 8,000,000 consumers of gas, and nearly 3,000 trades in which gas is used in varying ways. It has been one of the greatest contributors to the nation's health, comfort, efficiency and well-being; and I am convinced that in the search for means for providing the larger output of which the nation stands in such need to-day we must look to gas as one of the chief agents.

This being so, may I, in conclusion, say a few words which I hope will reach the eyes of many members of our Legislature? The Government has been considering the question of coal conservation, and of the provision of power. But it has been doing this from a single standpoint, and along a single line, with the result that special legislation has been passed for the electricity industry. Had the Government considered the matter exhaustively from all points of view, it would have been seen that the provision of power cannot be, if industrial economy is to be served to the utmost, the monopoly of any one agent. It would also have seen that the efficient supply of a heating agent is as important in industrial economy and the conservation of coal, as the supply of a power agent. I am sorry to say, but it is the truth, that the Government has been in this matter inexcusably short-sighted, as I think, my paper will have shown. Fortunately the Fuel Research Board has made a report upon which it is hoped legislation will be passed this session which will help the gas industry to render greater service to communities and industries. It is the duty of all members of your influential Society to urge upon their Members of Parliament that this should be done, and not only this, but that there should be revision of the statutory enactments relating to the capital of the same industry, so that capital may obtain a fair return for the service it renders, which it is not now doing—principally through the terms of the sliding scale of prices and dividends (which were determined on pre-war conditions) being out of harmony with what we must now accept as the newly established economic position. On the grounds alike of justice and progress, and to enable the industry to provide for the increasing demand for gas for manufacturing purposes, a modification of enactments is called for, and I hope the call will not be made in vain.

Finally, I wish to express my thanks to many engineering friends who have responded to my request for information on the subject treated in this paper, and to Brayshaw Furnaces and Tools, Ltd., The Davis Furnace Company (Luton), Fletcher, Russell and Company (Warrington), The Nautilus Fire Company (London), The Richmond Gas Stove and Meter Company (Warrington), John Wright and Company (Birmingham), for details of their appliances, photographs, and drawings.

DISCUSSION.

MR. D. MILNE WATSON said he had listened to the paper with the greatest interest. The author had put the case for gas, especially in connection with furnace work, in a most clear and able manner, and the slides he had shown had been excellent. He only wished that the author had not been speaking to a body of ladies and gentlemen who were probably all converted to the importance of gas, but that Sir Auckland Geddes and a few other people had been present. He

was sure the paper would have done a great deal to convince them that gas had to be reckoned with in any scheme of future development in this country. He thought the figures the author gave with regard to the economy of using gas instead of solid fuel should be spread broadcast throughout the country. Probably there were not very many people who realised the enormous economy that could be effected by using gas for furnace work, and he hoped that publicity would be given to the figures in the paper. Such papers were exceedingly interesting to those who were connected with the gas industry, because, however much they might be immersed in gas affairs, there was always a great deal to be learned from an expert like the author, and they realised what a great industry they had the honour to serve. At the same time, however, it was much more important that the information which had been so clearly and ably given in the paper should get into the heads of people who really knew nothing about the subject and were imbued with the idea that electricity was capable of doing everything and that gas was almost out of date. He was glad to say that recently people all over the country, and especially the people who counted in such matters, had begun to realise that that was not so, and that by the use of gas a great economy of the national coal resources was going to be achieved. He had very good reason for believing that the report of Sir Dugald Clerk and Professor Smithells did arouse the Government Departments that were concerned with the matter and made them feel that perhaps they were backing the wrong horse in backing electricity. Those who were concerned with the gas industry must keep on insisting on that, because if they did not save themselves nobody else would come forward to help them. They felt sure that the facts would ultimately triumph, but still there was so much error and wrong thinking abroad in the land at the present time that they should lose no possible opportunity of seeing that people were enlightened on the subject.

Mr. F. W. Goodenough said the paper was full of valuable facts and not merely opinions, and he could assure Mr. Milne Watson that every effort would be made to see that those facts were spread broadcast. The difficulty was to get people to read the publications that were sent to them, but every step would certainly be taken to see that those who ought to know the facts were made acquainted with them. The figures given in the paper were very striking, and some of them came almost as a surprise even to those who were closely connected with the gas industry; they hardly knew how very strong their case was. The author had stated in his paper that he could not deal with all branches of industry, but other people could say from their experience in trades other than those with which the author dealt that the same results had been found with regard to the increase of output per foot of factory, per hand employed, and per pound of capital expended, by the use of gas. The facts in the paper spoke for themselves and required very little comment or criticism, and he would therefore conclude his remarks by joining with Mr. Milne Watson in expressing his appreciation of the paper.

The Chairman (Sir Robert A. Hadfield), in moving a hearty vote of thanks to the author for his very able paper, said the author had put forward the facts in a very lucid and interesting manner. He considered it so valuable that he intended to distribute a number of copies of the paper to the staff in the laboratory of his own works. The author had rightly laid stress on the importance of temperature. One might heat a bar of steel to, say, 728° C., then quench in water and it would be soft; but, if one took the same piece of steel and heated it to only 2° or 3° more and then quenched it in water, there was obtained that wonderful product, hardened steel.

The resolution of thanks was carried unanimously.

The Author, in reply, said he hoped the paper would reach a larger audience when it was printed, and if it caused gas to be used in greater quantities for all purposes of production and thus increased the wealth of the nation he would feel amply repaid for any trouble he might have taken in preparing the paper.

The meeting then terminated.

GENERAL NOTES.

Ideal Homes Exhibition in Holland.—An ideal homes exhibition is to be held at Amsterdam from May 1st to June 7th. The promoters are the Nederlandsche Vereeniging Van Hursvrouwen (Afd. Amsterdam), and their aim is described as the demonstration of everything of a simple and economical nature that contributes to decorating and beautifying houses and homes. It is assumed that the exhibition will attract British manufacturers of furniture and allied products. The total space at disposal for actual exhibition purposes is 4,000 square metres.

Post-war German Imports.—The President of the Board of Trade, Sir Robert Horne, replying to a question in Parliament on April 12th, said that the imports into the United Kingdom during the past six months of goods consigned from Germany and classed in the trade returns of this country as wholly or partially manufactured were valued at £2,432,202. So far as he knew the German Government does not levy any export tax. The question of the benefit from the depreciation of the exchange rate of the mark depended on the terms of purchase, for example, whether payment was stipulated for in sterling or in marks.

Corrections.—In the *Journal* of April 9th, p. 336, col. 1, sixteen lines from the bottom, the date 1459 should be 1450; and in col. 2, six lines from the top, the date 1664 should be 1644.

Journal of the Royal Society of Arts.

No. 3,518. VOL. LXVIII.

FRIDAY, APRIL 23, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, APRIL 26th, at 8 p.m. (Cantor Lecture.) WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." (Lecture III.)

WEDNESDAY, APRIL 28th, at 4.30 p.m. (Ordinary Meeting.) BRIGADIER-GENERAL CHARLES H. SHERRILL, LL.D., "Ancient Stained Glass." THE RIGHT HON. LORD DESBOROUGH, K.C.V.O., will preside.

CANTOR LECTURE.

On Monday evening, April 19th, DR. WALTER ROSENHAIN, F.R.S., delivered the second lecture of his course on "Aluminium and its Alloys."

The lectures will be published in the *Journal* during the summer recess.

SEVENTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 21st; THE MARQUESS OF LONDONDERRY, K.G., M.V.O., Under-Secretary of State for Air, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Birrell, William, Loughborough.
Dobbs, Ernest John, Birmingham.
Walker, W. Ralph, J.P., Lochgilphead, Argyll.

The following candidates were balloted for and duly elected Fellows of the Society:—

Bellamy, F. S., Teneriffe, Canary Islands.
Board of Trade, Great George-street, S.W. 1.
Cleghorn, Miss Maude Lina West, F.L.S., Calcutta, India.
Colvin, Sir Elliot Graham, K.C.S.I., London.
Durham, The Right Hon. the Earl of, K.G., G.C.V.O., London.
Green, Frank Ernest, Uxbridge.
Griffith, John Henry, Llanbedr, Merioneth.
Jones-Keith, W., Rouen, France.
Keller, Miss Frances A., New York City, U.S.A.
Mutch, Stanley Robert, M.A., London.
Osborne, Charles Haddon, J.P., Luton.
Pole, Major D. Graham, London.
Randell, Charles Edmund, London.
Sankey, Charles Herbert, Chislehurst, Kent.
Sutherland, Daniel Manson, Teddington.
Taylor, John Brown, Dundee.
Wren, Captain Frederick, M.G.C., Bedford.

A paper on "The Commercial Future of Airships" was read by AIR-COMMODORE EDWARD MAITLAND, C.M.G., D.S.O., A.F.C.

The paper and discussion will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

FOURTEENTH ORDINARY MEETING.

WEDNESDAY, MARCH 17th; MR. WILLIAM KENNEDY JONES, M.P., Chairman of the Advisory Committee on London Traffic, in the chair.

THE CHAIRMAN, in introducing the author, expressed his pleasure at seeing so large an audience present prepared to take an interest in the problem of London traffic, a problem which affected every single one of the millions of this city, and which was now assuming a very acute form. He also conceived it to be his duty to express the pleasure of the audience at having the opportunity of listening to Mr. Worby Beaumont, a leading engineering expert on street traffic traction, and a gentleman, if he might say so, who had grown up with the motor industry. He (the Chairman) seemed to recollect that Mr. Beaumont was a pioneer even in the days when a

man with a red flag had to walk before a motor-car just as though it were a traction engine. He understood that the great charm of the papers read before the Royal Society of Arts was that there was freedom of speech; the author could advance any views he pleased, and when he had finished the audience could arise and demolish those sentiments. He anticipated something of that kind would happen at the present meeting, but as Chairman of the meeting he had to act impartially as referee, and in that capacity he would endeavour to do his best.

The paper read was --

STREET PASSENGER TRANSPORT OF LONDON.

By William Worby Beaumont, M.Inst.C.E.

Few things are more widely on exhibition for public observation than the methods and means of passenger transit of London and its suburbs.

Insufficiency forces itself into recognition, and defects are superficially observed and often wrongly interpreted. Hence a marked feature of the prevalent discussion concerning London passenger transport is the contrariety of opinion expressed and the consequent delay of unanimity of action. To some extent this delay is due to partisan element which enters into discussions, writings and conclusions of those who speak from the technical points of view for those who are concerned with the one or the other of the present systems and means of transport.

Some usefulness may therefore attach to a discussion of the arguments that are most commonly the cause of the fissiparous misdirection of public opinion and of the inconclusiveness of the proposals often made by those concerned in the present modes of conveyance.

There are but two systems of conveyance of passengers on the streets and roads of London which have to be considered with regard to their present and their probable future.

These are the street railways or tramways and the mechanically propelled omnibuses. All the other kinds of vehicles that are in use have only to be mentioned as things that get in the way of tramcars or have to be avoided by the omnibuses.

As a city with the largest population in the world, it requires the most comprehensive and efficient means of passenger transport ever called for.

Although the number of yearly journeys per head of the vast urban and suburban population of this great city—now about eight millions—had in a few cases been exceeded in some smaller cities, the total number has now by all modes of locomotion—rail, tram and bus—reached 393, and the number of passengers carried is the greatest ever known, and no mere statement of the numbers carried conveys any adequate idea of the bigness of the transport problem.

The figures available purport to show that in 1918, 198,334,499 passengers were carried by the tramcars and 652,562,327 by the omnibuses of the Electric Railway tram and omnibus group. The omnibus mileage for the year 1918 was 73,152,709 miles.

In 1918 the tramcars of the Underground group carried 164,159,233 passengers and the omnibuses 710,192,568. This last rose to 718,723,849 in 1914, but the omnibuses taken away for foreign war service in that year reduced the total in the following year to 655,333,017, a reduction of 63,390,830, and the tramcar passengers decreased in the same time by 1,521,433.

In 1913 the tramcars of the London County Council ran nearly 54,000,000 miles and carried about 512,652,653 passengers, and although this number decreased in 1914–15 it has steadily risen since then, and in the year ended March 31st, 1917, the number carried was 586,127,976, and in the year 1918 it was 636,157,431 and the car mileage was 49,189,866.

These figures are given merely to show how gigantic the surface passenger transport now is. The figures at the same time show the relative patronage by the public of the two systems.

Of tramways there are in the Metropolitan area about 348 route miles.

Those of the London County Council consist of 141·67 route miles, 121·89 of which are constructed on the conduit system, only 19·77 miles being on the overhead system.

The conduit system costs approximately £89,000 per mile, and the overhead about £50,000 per mile.

The figures showing the number of passengers carried by the tramways and the omnibuses are so differently stated by those who have given evidence, as in the recent inquiry before the Select Committee on London Traffic, that it is not possible to assert with certainty a nearly exact number.

The figures which are given, however, are sufficient to show how vast in numbers is the total in numbers of millions for whom provision has to be made, and the relative numbers carried by the two methods of transport.

The important question then is: How is

transport provision to be best made, not simply now but in the near future for carrying these millions, what vehicles are best and likely to be best for this present and for the future traffic?

At present the street transport accommodation provided consists of approximately:—

	Approx.
Tramcars and trailers held by the London County Council . . .	1,800
Omnibuses, London General Omnibus Company	2,550
Seats by Tramcars	136,800
Seats by Omnibuses	86,700

More accommodation is required to meet the present demand, even if the Metropolitan extension railway lines and stations, and the South-Western service to Ludgate-Hill, were again opened for traffic.

The London County Council is seeking powers not simply for additional cars, but for large extensions of tramway track. Some of these are extensions outside the areas at present served, but most are within what may be called the "inner" London area.

The omnibus companies are also increasing the number of omnibuses on the whole of their service routes, and are introducing an omnibus to carry 46 passengers instead of 34.

The London County Council had proposed to construct about 90 miles of new track at a cost of about £5,500,000 for track and equipment, and about £2,500,000 for street alterations to meet tramway space requirements. It has, however, now, it is understood, concluded that it is important in the opinion of the Council to proceed immediately with the construction of only 43 miles of single track. This, it is estimated will cost, including cars, cables, and street alterations, about £4,200,000, or about £97,630 per mile of single track.

If the schemes under this proposal were carried out, it would make the total length of the London County Council single track about 183·67 miles. The schemes include—

London County Council Proposed Tramway Extensions.

Description.	Length in terms of single line of track.			System of traction proposed.	Constructional cost per mile of single track.	Total cost, including acquisition of land and works for street widening.
	M.	F.	Ch.		£	£
1. Charles Street to Blackfriars Bridge . . .	1	3	3	Conduit	88,282	124,665
2. Gray's Inn Road to Farringdon Road . .	0	5	6	,,	106,714	75,750
3. Hampstead Road to a point north of the National Gallery.	2	2	2	,,	83,591	190,170
4. Victoria to Westminster Bridge	1	1	4	,,	83,374	110,465
5. Victoria to Westminster Bridge	1	7	8	,,	125,904	248,660
6. Victoria to Marble Arch	3	3	0	,,	82,166	277,310
7. Marble Arch to Cricklewood	7	5	6	Conduit and overhead	64,200	850,330
8. Edgware Road to King's Cross	4	2	6	Conduit	88,000	673,300
9. Shepherd's Bush to Marble Arch. . . .	5	1	4	Conduit and overhead	76,112	393,880
10. Seven Sisters Road to Stamford Hill . .	1	2	5	,,	67,041	87,025
11. Aldgate terminus to Aldgate Station. . .	0	1	6·2	Conduit	139,292	28,550
12. Aldgate to Tower Hill	0	6	0	,,	74,606	55,955
13. Tooley Street terminus to Hop Exchange .	0	4	6	,,	67,358	38,740
14. Waterloo Road to Blackfriars Road, *viâ* the New Cut.	0	4	4	,,	83,218	45,770
15. High Street, Wandsworth, to Roehampton Lane.	4	2	1	Conduit and overhead	38,526	357,220
16. Forest Hill to Crystal Palace	3	1	6	,,	46,808	209,285
17. West Norwood to Crystal Palace	3	7	8	Overhead	45,111	193,170
						£3,960,245
Spare cars, cables, etc.						245,100
						£4,205,345

It would appear from these figures of cost, which are extremely high, that the Council has some conception of the greater cost of construction in the busy thoroughfares of London as compared with that at any other time or in any other city in the Kingdom.

The conduit system is apparently to cost anything from nearly seventy thousand to nearly one hundred and fifty thousand pounds per mile of single track. Where a combination of conduit and overhead works is to be used, the average cost reaches about an average of

£58,537. On the one line on which overhead equipment is to be used the cost is estimated at £45,111 per mile of single track.

Among the seventeen lines included in these schemes, there are three on both conduit and overhead systems to be used, on which the change from plough to trolley-rod must be made during the journeys. These include the proposed line from Marble Arch to Cricklewood at a cost of £850,000, the Shepherd's Bush to Marble Arch at a cost of £393,000, and the Wandsworth to Roehampton Lane at a cost of £357,000.

There are two proposed lines between Victoria and Westminster Bridge, together 8 miles and 1 furlong and $\frac{1}{5}$ chain, which are estimated to cost over £359,000.

The London County Council tramways at present include, as above mentioned, 141·67 route miles, of which 121·89 miles are constructed on the conduit system.

In 1914 there were 1,452 cars used in working the London County Council system, or about 10 cars per street mile of track. In August, 1919, there were 1,210 cars and 112 trailers in use, and there are now about between 1,300 and 1,400 cars and trailers in use.

In the year ended March 31st, 1918, the total car mileage was 49,189,866, and the total number of passengers carried was 636,157,431. Hence the average number of passengers carried per car mile was 12·93.

The proposed new extensions, if carried out, would add to the car mileage, but it may be questioned whether the passengers carried per car mile would approach even that of the present lines.

The tramways of the companies and of the authorities, other than the London County Council, carried passengers in the year 1918 as follows:—

Electric Railway, tramway and omnibus group	198,334,499
Various London and Suburban authorities and companies .	157,398,343
Omnibuses in the year 1918, not including the "National," covered . . . . . miles	73,152,709
and carried passengers, 1918 . .	652,562,327
or, per omnibus mile, 1918 . .	8·93

Thus the number of passengers carried in Greater London during that year reached the colossal total of 1,644,452,600.

The omnibuses thus carried over two-thirds of the number carried by *all* the tramways, and 1·025 times the number carried by the London County Council tramcars.

For the future, then, the question arises: "What shall be the means of transport—the tramway and tramcar, tramcar and trailer, or the motor omnibus?"

It used to be—and with reason—said that the low resistance to traction on rails was a sufficient reason for the preference of the tramcar as compared with any then usual forms of road passenger conveyance.

This argument was good so long as public-service vehicles were all horse-hauled, or even for some time after the advent of the electric tramcar; but it ceased to be of any value about twelve years ago, when the light internal-combustion engine and modern mechanical design and materials, including good solid rubber tyres, had made the motor omnibus a tried, practical and commercial success.

It has become obvious that the relative carrying power of the tramcar and the omnibus cannot be represented by the number of seats of the two vehicles.

The tramcar has 76 seats and the omnibus 34,* or 2·3 to 1·0. From this comparison, it would appear that the tramcar should carry more than twice the omnibus: but the traffic figures show that the omnibus actually carries more passengers per seat than the tramcar, in the proportion 0·263 per bus seat to 0·17 per car seat.

This is a result of a number of differences in the character and appropriateness of the two kinds of vehicle for the work to be done and the streets and roads in which it has to be done.

In a paper recently read before the Institution of Civil Engineers, Mr. H. H. Gordon said: "There has been little premeditated effort to fit either the vehicles to the roads or the roads to the vehicles they are to accommodate." This, judging by its success, in contradicted by the omnibus, and it must be admitted that "premeditated effort" has successfully made great strides in the last dozen years toward fitting the roads of London to the requirements of the vehicles they are to carry. It may be urged, in fact, that one of the chief reasons for the success of the omnibus is its fitness for the conditions imposed by the roads, their other users, and by the public who want to ride on them.

It must be remembered that street vehicle transport does not consist simply in carrying.

* This will, in the near future, be rapidly increased to 40 or 46 seats, and the relative seating capacity of tramcar to bus reduced from 2·3 to 1·65.

Every kind of vehicle must stop somewhere to take up what it is to carry, and somewhere to put it down. Trading vehicles have to take up, and to stop for, delivery at shops and warehouses. The passenger vehicle which most fully accommodates itself and the passenger is that which can take him up with least inconvenience and danger, and can permit other vehicles to stop at shop and warehouse without itself being stopped. Thus it requires, and supplies, a freedom of movement which is only possible by dirigibility.

There is no validity in a complaint that frontagers use the streets as collecting and stopping places for the vehicles they employ, or that passenger vehicles stop at shop fronts. Were it not for the shops and various kinds of business places with street frontages, there would be no passengers through the great majority of them, and no reason for tramcars or motorbuses. That being the case the vehicles for passenger transport can seldom "keep in line" as Mr. Gordon wishes, and they would be the causes of the most aggravating obstruction if they did.

Within the areas of a conglomeration of cities like those which make up London, the variety and vast quantity of traffic—greater and of more variety than in any other place in the world—demand the greatest flexibility of movement for all vehicles, and this being so, the tramcar cannot, in the areas of greatest traffic of any of the kinds, meet the conditions as well as the dirigible vehicle.

It is not alone the published statistics showing the passenger carrying capabilities of the tramcar and the numbers, which indicate a choice as to selection of public - service passenger street transport.

So far as mere numbers carried per seat per vehicle mile, the public preference is plainly for the motorbus. This preference does not seem likely to be transferred to the tramcar as a consequence of any extensions of miles of route or of coupling up of existing lines.

What then is the cause of this preference by a public which does not concern itself with any of the questions of capital outlay or of relation between receipts and working costs which are the burden on those who supply the means of transit? What is the cause of the preference and of the success of which Sir H. Haward, the Controller of the London County Council complains, when he says that if there were less competition with motorbuses, the London County Council tramway undertaking could probably meet expenses on the present fares? This he says although the tramcars take all they can carry in the crush hours.

The answer to all this is the one word, convenience. The omnibus takes up its passengers from the kerb, just as the railway passenger is taken up from the platform of the privately owned station.

The omnibus with a slower maximum speed gives a higher average speed, although at a recent meeting of the London County Council the chairman of the highways committee stated that the average speed of the Council's cars was higher than that of the cars of any other city in the Kingdom.

The omnibus can and does ply with success and convenience to passengers through streets and round corners of narrow streets through which the tramcar could not pass.

The omnibus carries its passengers to busy streets in which no tramway could be laid.

Even to destinations to which there is no through route, the omnibus passenger can change at the kerb from one bus to another.

The full omnibus need not wait while one in front is filling or unloading, and one which will go south is not kept by two in front, one of which is in a mile, perhaps, turning east, and the other turning west off the same pair of rails, as for instance at either Blackfriars or Westminster.

The omnibus passenger knows that, even though it is possible, though seldom of occurrence, that his omnibus may develop some defect which may cause stoppage and a short wait for the next bus, he will not be subject to the long waits which attend the stoppage of from a few to a half mile of tramcars owing to a break-down of one car or of some vehicle on the rails.

These are some of the causes of public preference for the omnibus.

From the future utility and financial points of view, there are others of equal or greater importance which tell in favour of the omnibus, and appeal to the whole community and not simply to the tramcar or omnibus passenger *per se*.

The first of these is the fact that the omnibus runs upon the common highway, and although it can run on any road (witness the present condition of the neglected many), good roads suit it and its passengers better. This fact encourages the making and maintenance of good roads, because what is desirable by the omnibus is wanted by all the other multifarious users.

A second is that the tramways are the cause of very great delay all day long to the ordinary user of the road. They are also the cause of great numbers of accidents to vehicles and users of the highway, especially with the track in the condition it is in many places now. These causes must mean, with time and labour at their present value, thousands of pounds sterling losses per day.

A third is that the repairs to the tramway track are the constant cause of breaking up the road surface for small short-length repairs or long length replacements.

A fourth is that where tramway rails exist the continuity of the road surface is broken.

With the overhead system, two lines, the road is broken up into five rail separated sections with eight jointings between rails and paving.

With the conduit system it is broken up into seven sections with no less than twelve jointings between rails and paving.

It thus becomes exceedingly difficult to maintain a good road surface where the road is cut up into all these sections and many joints, and the continuity of surface so completely broken.

In many places the roadway is broken up into so many pieces that the proper paving material is only a sort of mosaic in the interstices of a steel rail network. One of the worst places is, for example, that at the Elephant and Castle and thereabout; but there are many others, as at Camberwell Green, St. George's Circus, and Finsbury and Islington. In some such places repair work is unending.

The statement has been many times made during the past few years that in the streets and roads, the tramcars use only the rails upon which they run. This statement has been made so many times by those interested, that they appear now to think it is true. It is, of course, as far from the truth as the finite is from the infinite. Yet the London County Council is now seeking powers that shall relieve the Council from the liability for the maintenance of the roadway in streets "in which tramways are or may hereafter be worked, with the exception of any rails or other works which may be used for the purpose of the tramway."

This demand is itself so regardless of the facts that it forms a proof of the incapability of the tramway system to meet its own trading costs.

Independent observers know that there are many parts of the road paving along the tram rails where the rails have worn down faster than even wood-paving setts, and the edges of the setts have actually been cut away, not worn by the ordinary vehicular traffic, but cut away by tramway workmen to allow the passage of the car wheels and to allow the track brake blocks to get down to the rails. In some places the corners of the granite or basalt setts have similarly been worn away by the passage of the car wheels and brake blocks. The road paving has everywhere to be broken up and re-laid alongside the rails, not because of the roadway requirements, but because of the rail and tramcar requirements. In some parts there are miles of road in which there are inspection holes and covers between the rails at every fourteen or fifteen feet, and in others inspection holes and covers in the space between the tracks forming complete user of the whole roadway. Yet the London County Council would ask the local authorities to pay for this part of their maintenance expenses.

A fifth reason is the uneasy feeling caused by the growing deficiency on the working of the tramways and the knowledge that a large part of the whole of the track system is in need of renewals which will cost an enormous sum. Sir H. Haward recently stated that the deficiency on the working of the London County Council tramways was at present (December 1919) £137,000, and that the estimated deficiency for the year 1920–21 would be £760,000.

With regard to these and other causes of suspicion in the eyes of those who are free to take a detached view of the tramway question, there are several matters of fact which affect their conclusions. The first is that obsolescence and cost of maintenance are dictating the fate of the obsolete. The tram rails they look upon as an anachronism for the streets of London, however appropriate they may be in Glasgow or in Buenos Ayres, and they hear of the tramway crisis in the United States.

They look at the leviathan London County Council tramcars weighing fifteen tons, or with seventy-six passengers nearly twenty tons, and compare this weight with that of other vehicles that are up-to-date, the motorbus for example, which they see is the lightest vehicle on the road per passenger carried. They compare the following figures:—

COMPARATIVE WEIGHTS OF THE TRAMCAR AND OF THE MOTORBUS PER PASSENGER CARRIED.

	Tramcar. cwts.	Omnibus. cwts.
With full load including driver and conductor	4·0	2·14
Half load	8·0	4·22
Quarter load	16·0	8·56
With seven passengers . . .	43·5	10·40

With such a dead load it is plain, even to the man in the street, that the tramcar labours under enormous disadvantages, even though the traction resistance on rails is less than that of solid rubber tyres on most common road surfaces.

This apparent advantage as to traction is, however, not to be seen in the power required by the tramcar.

The tramcar seating is 2·3 times that of the omnibus, but the passengers carried are not in anything like that proportion. The traffic returns, in fact, show that while the average of passengers carried has, as before stated, been only 12·9 per car mile (12 passengers to 15 tons of car, or 1·25 tons per passenger), the omnibuses carried 8·93 passengers per bus mile (8·93 passengers to 3·6 tons of omnibus, or 0·44 ton per passenger). Yet although the omnibus has only one engine of about 40 horse-power, the tramcar is fitted with two 40 horse-power motors each capable of about 100 per cent. overload, making a total available of 160 horse-power or four times that necessary with the omnibus. The tramcar thus requires 1·73 times or nearly twice the power per passenger seat that is required by the motor omnibus, or more than twice the power per passenger carried. A large proportion of this power is only required for the purposes of rapid acceleration of the heavy car, the high speed between stopping places now so generally used being easily maintained once the speed is reached. This high speed is one of the chief causes of the rapid deterioration of the permanent way and of the great cost of permanent way renewals and adjoining roadway.

So great is the wear caused by the powerful track brakes, which are a necessity with the high speeds, and are severely used at every stop, that the treads of the rails, as above mentioned, wear down much faster than the adjacent wood or granite paving. The result is not only damage to the road surface and the production of tram rail channels dangerous for most, if not all, the other users of the roads, but great cost to the London County Council for the cutting away of the rail cheek.

Only recently the Council entered into a contract with a firm for the removal by cutting away the high cheeks of 50 miles of single track rails at a cost of £14,500.

In many places tram rails are laid where very short radius curves are a necessity if the tramway is to be laid at all. At these places the wear of the rails, and especially the sides of the grooves, is enormous, and the car wheels suffer in acting as very blunt milling cutters under enormous pressures.

On all parts of the system the rails are subject to destructive rolling pressures by the small wheels of the heavy cars. This pressure on the whole area of contact of the pony wheels reaches 31·8 tons as a static pressure, and not less than 50 tons per square inch on the central part of the contact. With cars at ordinary speeds this pressure probably reaches at least 90 tons, and when at speed on long radius curves with the car heeling over so that the greater part of the load rests on the wheels on the outside rail of the curve it may considerably exceed 100 tons per square inch. The rapid destruction of the surface of the rails is the inevitable result.

Tramway constructing and working does not, especially in the greater part of London, permit of the adoption of modern engineering practice in many respects.

A great deal of tramway practice of to-day discredits modern mechanical engineering practice and science.

This is not the fault of the engineers and managers who are responsible for the present conduct of the tramways operation and maintenance. They have to do the best that is possible with an inherited system of construction and working, now an anachronism, and the wonder is that they succeed so well, though at a stupendous cost which is not their fault and would be greater but for their skill.

It may be asked, what are the causes of the grave defects which are summed up in these criticisms. They may be briefly catalogued as follows :—

1. The existence of the rails.
2. The use of very heavy cars.
3. The use of very heavy cars running on small wheels.
4. The very high speeds permitted.
5. The common use of magnetic track brakes rendered necessary and destructive of the rails by the high speeds between short distance stops.
6. The use of short-radius curves.
7. The destructive grinding of rails and wheels on short-radius curves.
8. The rigid fixture of both wheels on each axle causing most of the destructive grinding of wheel and rail and breakage of axles.
9. The use of a design and construction and working of cars which render the use of splendid material (manganese steel) in parts of the

permanent way only a palliative of the rapid destruction.

10. The use of a design and construction of car which ignores and makes impossible the advantageous use of modern mechanical engineering knowledge and experience in lightness of structure, high strength materials, and high efficiency mechanism.

On each of these points some further remarks must be made:—

Concerning 1.—The existence of the rails is the cause of the break of continuity of the road surface and bed, and of the cost of the contiguous road repairs. The fixity of the rails, the path of the tramcar, is the cause of the arrogation of a car in a crush and the origin of obstruction and congestion.

Concerning 2.—The use of very heavy cars is the cause of unnecessary high cost of working and high cost of maintenance of its axles, its wheels and tyres, its track brakes and its operating mechanism in spite of its possession of electric motors which cannot be too highly praised as fine pieces of up-to-date mechanism.

Concerning 3.—The use of the small wheels of tramcars and the consequent excessive pressure per unit of surface contact on the rails, causes the elastic limit of extension of the steel at the point of maximum intensity of pressure to be exceeded. Hence, by a process as I have elsewhere explained, the origin and production of corrugation. This is the cause of another large item of expenditure. It is also the cause of excessive noise and of annoyances to people in houses along the tramway route.

Concerning 4.—The very high speeds make it necessary to put the brakes on while the car is still at a high speed in order that the time occupied at stopping places shall be as short as possible and so that an average speed comparable with that of other vehicles can be maintained. To attain this high speed between stops the high power and big current consumption for rapid re-acceleration after each stop are required.

Concerning 5.—This use of the brakes is a great cause of the rapid wear of the rail treads and of leaving the check standing up high above the tread. It results in the necessary waste of rail material by fusing off or cutting away the check by the special appliances referred to, or breaking it off by sledge hammers as is often done. It also results in serrated and knife-like edges which cut every rubber tyre that passes over them, and in a condition of the permanent way which is a source of accident to other vehicles and cycles, and of losses daily which in £ *s. d.* it is difficult to estimate.

Concerning 6.—The use of short-radius curves is dictated by the desire to lay lines in situations which are unsatisfactory for railway purposes. The obvious mechanical unfitness is defied, and the consequence is that a barbarous use is made of costly materials which would make engineers in any other branch of engineering admit the inadequacy of language.

Concerning 7.—The use of tramcar wheel flanges as crude milling cutters for irregular shaping out of rail grooves is as costly as it is barbarous. Examination of these grubbed-out grooves and sides of checks shows how the alternating rise and fall of the wheels in their efforts to leave the grooves carves them out, and an examiner may wonder that the cars do not more often jump the track than they do.

Concerning 8.—Except on railways where the wheels used are large and where there are no small-radius curves comparable with the small curves on tramways, there are nowhere heavily loaded pairs of wheels rigidly fixed to the ends of an axle. Every time a tramcar passes over a quarter circle of, say, 50 ft. inner rail curve radius, the wheels have a difference of length of path of 3 ft. 9 in. The axles have to carry the torsional stress of twisting the wheels over this distance forcing the wheels under their heavy load to slide and grub and grind over the rails instead of rolling over them.

Concerning 9.—The enormous weight and power of the cars on small wheels at points, crossings and curves, is the cause of cutting, grinding and rolling wear, so rapid of even the tough and hard materials used, that in any other branch of engineering such wear, tear and waste would be admitted a more than sufficient proof that an entire change is necessary.

Concerning 10.—The cars at present employed seem to be built on the principle that excessive weight in every part is of no harm and is required for frictional adhesion on the rails.. Whatever the cause the great weight is recognised by Mr. A. L. C. Fell, the engineer of the London County Council tramways, as he recently said cars of lighter weight were desirable As a vehicle for carrying passengers for street traffic it is of excessive weight in almost the whole of its steel work, its framing, its under and running gear, and in the whole of its body work. Added to this is the excessive weight of scantling of the covered top, from the proportions of which it might be thought that several

tons of something were to be carried on the roof, when in reality its duty is only that of a good umbrella.

In conclusion then as to what is to be done in the future.

1. We see that the cost of running the present system of heavy tramcars, especially on a conduit system a few years after installation, does not pay.

2. We see that the carrying capacity in actual practice of tramcar and of omnibus is not directly in proportion to the seating capacity.

3. We see that the greater convenience of the omnibus, taking up its passengers at the kerb and free to move off as loaded independently of others in front and independent of rails, can, and does, carry one and a half times the passengers per seat mile carried by the tramcar.

4. We know that if omnibuses were in service they would run on the sides of the road and accommodate themselves to all other users of the road and run in accordance with its rules and usages, instead of monopolising the whole of a roadway as the tramway does in effect in most streets and does actually on the Victoria Embankment, or causing confusion and obstruction as it does in nearly all busy thoroughfares.

5. Judging by the proved capacity of the omnibus in passengers per mile, its proved rapidity of loading up and celerity of dispatch, it is now evident that an increase in the number of omnibuses of perhaps slightly more than the present number of tramcars would make the tramways and tramcars as unnecessary as they proved to be in the Liverpool Road, Islington.

6. The question of cost of the removal of the tramways, and restoration of the highways to their proper condition for all purposes need not perhaps be now considered. The London County Council could sell the cars as they have sold a considerable number for use in towns where tramways are of more suitable employment than they can possibly be in London. The rails and plant could probably be sold for a great deal more than the cost of reinstatement of the roadways.

7. It is probable that the vast number of traders in London, whose vehicular repairing costs and drivers and attendants' time costs would be so much lessened by the absence of all tramways and tramcars, would find a plump subscription for provision of a redemption fund, and for paying the difference between the receipts from the sale of the whole of the tramway materials and equipment, and the cost of the reinstatement of the roadways, a profitable investment.

It is to be regretted that this conclusion follows on the facts herein dwelt upon, but it is a conclusion which in some other fields has similarly had to be faced as a result of entrance upon a trading enterprise, the foundations of which have become obsolete. However, "What cannot be avoided 'twere childish weakness to lament or fear."—3. *Henry VI.*

DISCUSSION.

THE CHAIRMAN (Mr. Kennedy Jones, M.P.) said he was sure the audience would agree with him when he said that they had listened to a careful, interesting, informative, and, he might add, a provocative paper, which was likely to produce a great deal of criticism and comment.

MR. H. H. GORDON, J.P. (L.C.C. and Member of the Technical Committee on London Traffic), said there were certain points on which he was in complete agreement with the author, and when Mr. Beaumont called attention to the many structural points of engineering practice as applied to tramcars, he had good grounds for the criticisms which he had made. For instance, when Mr. Beaumont criticised the excess of weights and the frequent misapplication of good material, he (Mr. Gordon) fully agreed with him. But those, after all, were matters of detail, and ones which could be cured in the next tramcar built. Far more important—and he ventured to submit it was the only basis on which to come to a conclusion on the matter—was the larger question of whether the tramway systems were still required to minister to the traffic needs of the metropolis. If he might say so, the author of the paper had only partially studied the problem of London traffic. Mr. Worby Beaumont seemed to imagine that London traffic flowed in an even flow. That was a fatal fallacy. London traffic had immense tides. Those tides of traffic were vital if the trade and industry of London were to be carried on. Mr. Worby Beaumont had called attention to the fact that an omnibus carried more passengers per seat provided than did a tramcar. That was admittedly the case, but why was that so? The tramcar was the only vehicle in London, on the surface of the streets, which dealt with rush hour traffic. No one was going to suggest that in the morning when a tramcar was carrying 120 passengers that it was not doing the utmost service to the metropolis. An enormous tramcar service was run purely on peak load periods. When there was little traffic the number of cars was reduced. The omnibus only took an even load, and did not attempt to deal with the glut of London

traffic. When the demand was at its highest the omnibus companies did not attempt to put an extra omnibus on the service. He had shown recently at another place that the load-curve of the motor omnibus was a dead straight line, but that the load-curve of the tramcar was an enormous peak going up in the morning, coming down low in the middle of the day, and going up again to an enormous peak in the evening rush hour period. In those circumstances the tramcar provided a much larger number of seats per passenger than did the omnibus, and naturally, therefore, the feature to which the author had referred, namely, that the omnibus, which only did an even load, had a larger number of passengers per seat than the tramcar, was true. But he asked the audience to suppose for one moment that the tramcar system of London was abolished and omnibuses substituted in its place. He was rather amazed to hear the author state that only a few more omnibuses would be required to carry the tramcar traffic. It was really amazing to think that the problem of providing accommodation for one thousand million passengers — 50 per cent. more passengers than were being carried by the omnibuses to-day—was a task which could be so lightly undertaken as the author had suggested. What did it mean? As he had said, at rush hour periods there were frequently not 78 passengers on a tramcar but 120. But even taking the lower number of 78, and comparing it with motor omnibuses, 2½ motor omnibuses would have to be provided to carry one tramcar load. That meant that whereas there were already more than sufficient omnibuses to carry the normal traffic in the middle of the day, there would be 2½ times as many omnibuses added for which there would be no work to do in that period. Under the labour conditions at present prevailing, it was impossible to run a transit organisation successfully unless a working day was provided for the staff. He would like the author to work out how many omnibuses would be required to carry the peak load of the County Council tramways; what was going to be done with the omnibuses in the slack hours of the day; how much the fares would be; and how the system was going to be operated? Mr. Worby Beaumont had alluded to the fact that at the present time the County Council tramways were working at a deficit, but he ought to have carried his observations further. He had stated that the County Council tramways would, in the ensuing year, make a loss of three-quarters of a million, but did Mr. Worby Beaumont know that, at a recent meeting, Lord Ashfield, the Chairman of the Omnibus Company, had mentioned that the loss which was going to accrue to the omnibuses during the coming year was £1,600,000? It was clear that the problem of London traffic must not be treated in a light-hearted way. It was a serious and difficult problem, in the solution of which had to be employed not one means of transit but every means of transit. He said emphatically that there was room in London for the tube railways, for tramways, and for motor omnibuses. Instead of a policy of competition, there should be a policy of co-operation. There should be introduced what at present was non-existent, namely, a more efficient road transit system in London. If there was co-operation instead of competition, he ventured to say that there would be no talk of transit agencies being bankrupt, but of those agencies ministering to what was the paramount need of London at the present time, namely, an efficient transport service for the metropolis.

Colonel R. E. B. Crompton, C.B., said he begged to call attention to the fact that Mr. Gordon had entirely missed the point. The question was the occupation of the surface of the London streets by traffic, how to minimise congestion, and how to move passengers over the streets with the least congestion, with the greatest rapidity, and with the greatest convenience. Therefore it resolved itself into the simple question—which vehicle could transport the greatest number of passengers in a given time over a given surface of roadway. He had supplied on a previous occasion the figures of what omnibuses could do at the present time, and what they would do when the new 46-passenger omnibuses were on the streets, as they would be very shortly; and Mr. Gordon had not answered those figures. He considered that Mr. Gordon had yet to prove that those figures were wrong. Those figures showed that the carrying capacity per yard, or per area of roadway, of motor omnibuses as they were now was nearly 50 per cent. in excess of the carrying capacity of the tramways occupying the same road surface; and with a 46-passenger omnibus it would be doubled. But that was only one aspect of the question. He thought the majority of engineers were with him when he said that the advent of the motor omnibus, and the amount of thought and design brought into the motor omnibus, had rendered the tramcar completely obsolete. The tramcar was an obsolete piece of engineering. Again, it was the most obstructive thing possible in the streets, particularly in South London. Tramcars had been laid through streets through which they never should have been laid. The space on the near side between them and the kerb was so small that no other vehicle could pass, so that a slow vehicle running alongside the tramway held the road and prevented any faster vehicle from passing. The tramcar with its excessive weight and size was an obsolete vehicle occupying twice the space of a motor omnibus, and was so obstructive that it ought to be done away with as early as possible.

Mr. Henry Ward, L.C.C., said he was surprised to find two engineers of such eminence as Mr. Beaumont and Colonel Crompton stating that rail-borne traffic, such as trams, was likely to give way to road-borne traffic. If that were the argument, it might almost be said that road

transport would do away with the railways, and that all passengers and luggage would be carried along the road. The power required by rail-borne was so much less than that required to carry weight on roads that the former would always beat road-borne traffic. Mr. Worby Beaumont had started by begging the question. He had asked why the public preferred the omnibuses. He (the speaker) had thought the audience were going to be given proof of that statement. As a matter of fact he, the speaker, wanted to know why the London public preferred the tramcars, and he could give the reasons why they did so. The cubic space which a passenger had on a tramcar was nearly double that which he had on the omnibus. The vibration on a tramcar travelling on the road was far less than that on an omnibus. Nobody would contend that the ventilation in a tramcar was not superior to that in an omnibus, and again what discomfort did a poor passenger undergo on the top of an uncovered omnibus in wet and stormy weather? It was true that in order to provide that superior comfort on the part of a covered-in tramcar its weight had largely to be increased, and that unfortunately increased the strain on a tramcar very much more than the extra weight would involve, because the weight was put up at a great height, and therefore acted with a big leverage when it had to be transferred to the rails. Another point in the tramcar's favour was that it alone dealt with the rush load. Further, it dealt with the great problem which was vital to all municipal transport, namely that our centres of population were now becoming so congested that the people must, by hook or by crook, be carried to the outskirts. The working population could not afford to pay omnibus fares night and morning, and the result was that the carrying of workpeople backwards and forwards to the outskirts was not undertaken at all by the omnibus but by the tramcar. That was one piece of work which the tramcar would always have to handle to the exclusion of the omnibus. With regard to the loss on the London tramways, that was reckoned not as it was reckoned on the omnibus line. The London County Council first had to pay all their dividends in the form of interest to those people who had lent the money. It was only after that that they began to mention loss, whereas the omnibus company simply paid no dividend at all, and so long as its income and expenses met it might be said that they ran without loss. Another point was that every year the County Council had to pay off nearly half a million of its capital. They had paid six millions from their income out of fourteen millions of capital, and that was charged as costs of working the cars, not merely interest to those who had lent the money. That very heavy sinking fund would enable the tramways to be handed over free of cost to the ratepayers as a going concern at the end of something like twenty-five years—a very different state of affairs from that of the omnibus company. The author had not written a paper on the Transport of London, but had given a contribution which praised omnibuses and did not mention a single one of their defects, and which from end to end damned the tramways.

Mr. H. Percy Boulnois said that, having had control of tramways and also having had a large control of roads during his lifetime, he ventured to state that he could not help thinking that the London County Council had now found they were backing the wrong horse and were trying, in common phraseology, to camouflage the position. They were losing money on the tramways and they would continue to lose it. To his mind the tramcar was not either a mechanically designed vehicle nor was it a convenient vehicle. With regard to the peak loads and the rush hours, they could equally well be dealt with by omnibuses if there were a sufficient number of them, and to prove that statement he had merely to point to the instance of Victoria Station where people coming from the trains were distributed in every direction by the omnibuses there waiting for them. The speaker then proceeded to give a list of defects connected with the tramway, mentioning the lack of mobility of tramcars—tramcars having to follow each other in a rigid line and not being able to move to right or left; the fact of passengers having to get off in the middle of the street with the consequent danger attached thereto; the fact that the cars were the greatest obstructors of traffic ever introduced; their excessive grinding noise; and the great annoyance caused to the sleeping population by the fact of repairs having to be done during the night.

Mr. G. H. Hume (L.C.C. and Member of the Advisory Committee on London Traffic) said if he had shut his eyes during the delivery of the paper he should have imagined that he was listening to an expert witness in the Law Courts called to defend one particular side of the question. Everything had been said that could have been said in favour of the omnibus, and nothing at all had been said in favour of the trams. He personally did not desire to go into the question of the omnibus versus the tram. The traffic authorities in London had a far greater problem than that to consider. The traffic problem in London was not merely one of congestion but how to get the population backwards and forwards. The present was no time to shut down any means of conveyance. The number of journeys per head of the population was increasing rapidly, and it was absolutely essential that an endeavour should be made to mobilise all means of transport in order to meet the situation. Whether trams were obsolete or not, they were very badly needed in many parts of London in order to meet the present need, which need could not be met otherwise. Omnibuses had not attempted to meet the demand of the peak load period. The London County Council were not against motor omnibuses; in fact they were seeking powers to run them. The question of tramways versus omnibuses seemed to

those who were in the thick of the problem almost like a childish exercise. The deadly part of the matter was that if statistics from a controversy of such a kind came to the ears of the legislators at the present moment it might well induce them on partial consideration of the question to refuse the offer of the London County Council. The London County Council was offering to solve the problem in a practical way, and was saying that in spite of the cost they were going to try to meet the public need by laying down forty more miles of tramways. There was nothing else in the field to deal with the situation, and the danger of a paper of the kind which had been given that afternoon was, as he had said, that it might induce the House to refuse the London County Council's offer, which, if refused, might not be made again.

MR. W. M. ACWORTH said it was rather a pity that the discussion, which he thought was to have been a discussion on the best means of solving the problem of London traffic, had come to be a discussion on the question of whether the London County Council was or was not a virtuous public servant. He could not help feeling that that was a mistake. He could agree with Mr. Hume that at the present moment, at any rate, to talk of getting rid of the tramways was not practical politics in the interests of London. He did not think it was desirable to discuss the abolition of tramways at the present time, but when it came to a matter of extensions that, he thought, was a point on which people were entitled to hold a different opinion. The County Council were proposing to bring tramways past Westminster Abbey, past Marble Arch, and across the foot of Ludgate Hill. That was an entirely new departure. It meant the trams were coming into some of the most important and congested traffic centres in London. He did not think that was a step which should be taken without more general approval. That the approval was not general was proved by the fact that there were some eighty odd petitions against the London County Council Bill in Parliament, which petitions included practically every local authority in the middle of London. Dealing with the present situation, there were two points which had to be considered. One was the peak load. Nobody was going to argue that under present conditions the omnibuses could deal with the peak load. That was perfectly clear. The tramways were there, and for that purpose were at present essential. The future was another matter. But, meanwhile, the fact of the peak load had to be faced, and it did seem to him that it ought not to be past the wit of man to make some arrangement by which omnibuses and the tramcars could be worked in harmony to do the best they could for dealing with what were two perfectly different things, namely, the traffic as it existed along Oxford Street where it was much of a muchness all the day long, and the traffic which came from the outskirts to the centre of London. The other point was that the tramways had got to accept the fact that London being what it was they could not do what the omnibuses could do. They could not, for instance, go up Bond Street. He really could not imagine that tramways could be worked up Bond Street to the greatest happiness of the greatest number. If that were so, there was a separate field left for the omnibuses. As to how big it was, Mr. Gordon and himself would probably disagree on the details, but he could not help thinking that they would agree that there were points which the omnibus could reach, and districts which the omnibus could serve, which the tramcar could not equally well serve. It did seem to him a pity that the different people interested were not getting together on points of that kind, and seeing whether something could not be done which would save London from the grossest inconvenience for at least the year to come. He thought it very desirable that those interested should get together and try to find whether they could not, by a co-ordination of the machinery available, make a better result for London as a whole than it was possible to do under present conditions.

MR. WILLIAM WORBY BEAUMONT, in reply, said the remarks of Mr. Gordon during the discussion and also his remarks which he had made on a previous occasion, showed that he was almost incapable of seeing anything on the subject unless he saw it through a tramcar window. He need hardly say that he agreed with Colonel Crompton's remarks. With regard to Mr. Ward's remarks, he would simply say, in order to cut the matter as short as possible, that he too saw things only through a tramcar window. With regard to Mr. Boulnois' remarks he had nothing to say in reply, because no one could object to them. With regard to Mr. Hume's remarks, Mr. Hume, like other speakers, spoke of the matter as purely a tramcar question, and practically expressed the view that everything else must be subordinated to tramway matters. With regard to Mr. Acworth's remarks, he (the author) had not been discussing so much the abolition of any system; the argument was that the proposed new extension should not be carried out. Not one of the speakers who had adversely criticised his remarks concerning tramways and tramcars in London had controverted a single one of the salient facts or reasons given in the paper.

THE CHAIRMAN, in moving a vote of thanks to the author for his paper, said the paper had rather tended to increase the mental indigestion from which he had been suffering for some months. During the last hour and three-quarters he had felt very much in the position of the small boy who, having surfeited himself with mince pies on Christmas Day, was asked at the end of the day if he would not try just one more, and his digestion did not rise to the occasion. He (the Chairman) had suffered, and was suffering, from mental indigestion concerning traffic statistics and figures, and the question of the values of the

different vehicles and different methods of transport, because they had been produced in excessive quantities. It had been his fortune in the last nine months to preside over two committees dealing with the question of London traffic, and incidentally inquiring into the transit values of tramcars, tubes, buses, and various other forms of vehicles. His second committee had still to report, and therefore personally he must for the time being remain silent as to any phase of the very interesting paper which had been presented that evening. He was very glad to see so many people present prepared to study the question of London traffic, because until the public themselves had a very shrewd appreciation of all the difficulties, it would not be possible to do very much in the matter; but he would warn them from his experience that if they entered into the study of traffic, thinking that the acquisition of knowledge on the matter was an easy task and that they could discover remedies after a few hours' consideration, they would soon find that that was not the case. He would further warn them that they would venture on to a battlefield where tables of figures would be thrown at them, and where the arguments of the parties on both sides would be bewildering and confusing. On the previous day he had had no knowledge of the character of the paper; if he had, he did not think he should have been present, because painful experience had taught him to approach the controversial aspects of the traffic problem with the utmost caution, and he hoped always with due modesty. Anyhow, there was the fact that if people were going to approach the question they should consider it in its wide and broad aspects rather than from the point of view of whether the tram was better than the bus or the bus better than the tram.

The vote of thanks was then put and carried, and the meeting terminated.

Mr. A. A. Parsons, of the Palmer Tyre, Ltd., writes:—Metropolitan motorists generally appear to appreciate the dangers their tyres are exposed to from defective tram-rails and points. Speaking as tyre makers we find fewer cases of tyres damaged in this way coming under our notice for repair than was the case eight or ten years ago, and as the condition of the tramway tracks in London has very much deteriorated in the meantime, and particularly during the last four or five years, we can only attribute this falling off to greater care on the part of motor-car drivers. It is noticeable to anyone who does much driving in London, that drivers avoid as far as possible running with either near or off-side tyre directly on the rail, and are particularly careful at junctions and cross-overs. In the case of experienced drivers, it is only when they are forced directly on to the rails that they run any serious risk. Vulcanised rubber of good quality is not easily cut, and it is generally known that if rubber has to be cut with a knife water is the best lubricant. In the course of conversation with car owners we have found that in the majority of cases injury to the treads of tyres from knife-edge tramway points has usually been caused when the track and tyres are wet. The injury, as a rule, consists in the slicing off of a piece of tread of an irregular shape with an area of from six to ten square inches. Very frequently the piece of tread is not entirely detached. Our theory is that most of these mishaps are due to the tyre slipping on the smooth and sometimes greasy surface of the rail while a portion of the tyre tread is in contact with the knife-edge of a badly worn point. It is usually at junctions that motorists have to slow down, and it is quite conceivable that what we have described may easily happen while the speed of the car is being retarded or in accelerating after having been brought to rest or nearly so. Our theory seems to be confirmed by the fact that it is almost invariably the driving-wheel tyres which sustain injury. It has been quite a common thing within the last few years to see lengths of the running surface of the tramway rail broken away for a space of from 18 inches to 3 or 4 feet. This, as far as our observation goes, generally occurs where the granite sets are some inches below the rail head. In such cases the jagged edge of the rail thus exposed is likely to cause injury to pneumatic tyres, but we have not been able to trace any serious percentage of tyre damage to this cause. Mishaps such as we have described undoubtedly prove a form of indirect tax on the motorist. Satisfactorily to repair the sliced tread would cost from £2 to £3, according to the size of the tyre. If the car owner neglects to have the tyre repaired and continues to use it in its damaged condition the total mileage, in the case of a comparatively new tyre, is usually reduced by something like 40 per cent., because the foundation is naturally first exposed at the point where the rubber has been cut away from the tread. If the average price of a tyre at the present time is taken at £8, it means that mileage to the value of something like £3 4*s*. has been lost to the motorist. On looking through our records it would appear that the tyres received from London users classified as being, in our opinion, injured by tramrails only represent ·5 per cent. of the total number of our tyres estimated to be in use in greater London, so that it cannot be said that the conditions of the tramway tracks—bad as they are—are responsible for any great mortality of tyres, and it should be remarked that the cases in which the foundation of the tyre is damaged at the same time as the tread are extremely rare.

Mr. E. H. Beckwick, of Chas. Macintosh & Co., Ltd., writes:—Tramlines always have been looked upon as being very detrimental to any rubber tyre, and more especially where, through road repair neglect, they are allowed to project above the level of the adjacent paving. This is more particularly the case at junctions, which are usually so crowded with traffic that it is impossible for the most careful driver to avoid them, and this, of course, is highly prejudicial to us as tyre manufacturers. Apart from tyres, the damage caused

to the axle and wheels of vehicles by tramway metals is enormous, and their abolition in favour of some more modern means of transit would, I have no doubt, receive the grateful thanks of every vehicle owner using the streets of London.

MR. GUY BEAUMONT, A.M.Inst.C.E., writes:—The subject dealt with by the author renders comparison of available passenger transport methods both desirable and unavoidable. I should like to be permitted, as one of those present, to express disagreement with some of the stated opinions of those contributing to the discussion. I do not find in the paper any proposal that the passenger transport facilities should be curtailed by reduction of any of the several systems now working, but there is, on the contrary, an undoubted appeal to logical consideration and impartial investigation of relative merits in order to secure future improvement. This is indicated by the early occurrence in the paper of the following sentence: "For the future then the question arises: What shall be the means of transport—the tramway and tramcar, tramcar and trailer, or the motor omnibus?" Mr. H. H. Gordon stated that the omnibus could not deal with the peculiar difficulty of rush-hour traffic, and referred the meeting to the lecture recently delivered by him before the Institution of Civil Engineers upon "Some Aspects of Metropolitan Road and Rail Transit." In this lecture the following information is given or definitely indicated by included diagrams (see p. 36, Fig. 10). On a typical popular route over an eighteen-hour period, motor omnibuses carried 67 per cent. and tramcars 33 per cent. of the the total passenger traffic of the two systems. During the rush-hour period—8 to 9 a.m.—the omnibuses carried the same number of passengers as the tramcars within 3 per cent., and if the period 8 to 10 a.m. be taken the omnibus totals much exceed those of the tramcar. The same or nearly the same proportions obtain for the evening rush-hours. These figures, derived from Mr. Gordon's paper, conflict with his statement in the discussion, but they do support my experience in observation of the working of both tramcars and omnibuses at rush-hour periods. The figures quoted in the same lecture (see p. 23) also indicate that the omnibus is a very large and much-appreciated contribution to the London passenger transport facilities. I desire to take the opportunity afforded by the reading of this paper to concur in the statements of those who, in the discussion, claimed that the motor omnibus method is already demonstrated to be superior to the tramway method of dealing with metropolitan passenger traffic, and that the time has come for courageous and unequivocal decision in favour of the better system, and for effecting the change as rapidly as public convenience and financial consideration permit. In conclusion, it is interesting to note that the author pays a well-deserved tribute to the tramway engineers and managers, and records the disadvantages they have had to labour against.

OBITUARY.

THEODORE N. VAIL, LL.D., D.Sc.—The death is reported from New York of Dr. Theodore Newton Vail, who was elected a Fellow of the Royal Society of Arts in 1916. He was born in Carroll Co., Ohio, in 1845. After studying medicine for two years he entered the engineering profession. In 1873 he was appointed assistant superintendent of the railway mail service, Washington, and rapidly rose to the position of general superintendent. But his principal work was done in connection with the telephone service. For ten years he was president of the American Telephone and Telegraph Company, in which period the "Bell" telephone system in the United States increased from 6,000,000 stations to nearly 12,000,000, and the range of the telephone was extended until it covered the whole continent, and New York was able to speak with San Francisco. Dr. Vail fully recognised the importance of scientific research, and during his presidency of the company he organised a research department, which is probably unsurpassed in the world to-day among technical laboratories. The enormous development of the telephone service in America is very largely due to his efforts.

Dr. Vail was well known in London, where he lived for several years at a time when he was busy developing electrical enterprises in South America.

GENERAL NOTE.

FRENCH RAILWAYS AND THE WAR.—During the four and a half years of war the French railways have rendered great service to the national defence in the transportation of vast quantities of war material, food supplies, troops, etc., notwithstanding almost insurmountable difficulties. The Paris-Lyon-Méditerranée system in five weeks ran 1,600 extra trains, making an average total of 45 trains per day. In 1915 the same system transported 70,000 Sikhs and Gourkas, who had been landed at Marseilles. In the same year the Orleans system ran 400 trains, at times at six-minute intervals, to carry Hindoo troops from Toulouse to Orleans. The Southern Railway transported 600,000 men and 96,000 horses and mules. During 1915 also the Northern system operated more than 114,000 trains, or an average of 320 trains a day, not including hospital trains and those carrying soldiers or munitions of war. In 1915, for revictualling the army in food products and munitions of war, 60,000 complete trains, or an average of over 160 per day, were operated by the Northern Railway; the Southern Railway carried 617,000 tons of food products and munitions and 584,000 tons of various kinds of merchandise; the Orleans system carried 11,000 guns and cartridges, and in addition ran about 85,000 loaded cars. And from August 20th to September 30th, 1914, the latter railway carried 117,000 tons of food products, 65,000 tons of forage, 107,000 cattle, and 215,000 head of sheep and hogs to feed Paris.

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FRIDAY, APRIL 30, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, MAY 3rd, at 8 p.m. (Cantor Lecture.) ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758-1837." (Lecture I.)

WEDNESDAY, MAY 5th, at 4.30 p.m. (Ordinary Meeting.) DR. C. E. KENNETH MEES, "A Photographic Research Laboratory." SIR HENRY TRUEMAN WOOD, Chairman of the Council, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

Owing to a sudden attack of influenza, DR. WALTER ROSENHAIN, F.R.S., Superintendent of the Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, was unable to deliver the third lecture of his course on "Aluminium and its Alloys" on Monday, April 26th. It is hoped to arrange another date for the lecture, and notice will be given in the *Journal* as soon as this is fixed.

EIGHTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 28th; THE RIGHT HON. LORD DESBOROUGH, K.C.V.O., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Anderson, Sir Alan Garrett, K.B.E., London.
Dunning, Major James, D.S.O., London.
Hart, Charles, F.S.S., Moseley, Birmingham.
Howard-Flanders, Richard Leonard, M.I.Ae.E., Latchingdon, Essex.
Kneass, Strickland L., Philadelphia, U.S.A.
Mayrow, J. J., London.
Sherrill, Brigadier-General Charles H., LL.D., New York, U.S.A.
Visvesvaraya, Sir M., K.C.I.E., M.Inst.C.E., London.

The following candidates were balloted for and duly elected Fellows of the Society:—

Abbott, Hon. R. H. S., Bendigo, Victoria, Australia.
Allen, William Thruston, Waipiro Bay, New Zealand.
Buchanan, John, Port Sunlight, Cheshire.
Cross, L. W., London.
Hitchcock, Eldred Frederick, C.B.E., London.
Mansukani, Gulab, M.B., B.S., London.
Marshall, Mrs. M. Katherine, Totley, nr. Sheffield.
Mather, Frederick, B.Sc., Barcelona, Spain.
Matsukata, Goro, Tokyo, Japan.
Savi, Ernest E., London.
Taylor, Captain T. Smithies, Steep Petersfield, Hants.
Wheeler, Major Charles, R.A.S.C., O.B.E., M.I.A.E., Bushey, Herts.
Yorke, Mrs. Constance E., F.R.G.S., Southsea, Hants.

A paper on "Ancient Stained Glass" was read by BRIGADIER-GENERAL CHARLES H. SHERRILL, LL.D., of New York, U.S.A.

The paper and discussion will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Friday, March 19th, 1920; THE RIGHT HON. LORD CHALMERS, G.C.B., LL.D., in the chair.

The paper read was—

THE INDIAN CURRENCY SYSTEM AND ITS DEVELOPMENTS.

By SIR WILLIAM MEYER, G.C.I.E., K.C.S.I.

Controversies on currency matters are sometimes waged with an almost religious fervour, but I do not propose to devote the paper I am about to read you to polemical preachings. My object is less exciting, but perhaps more useful—to give you a short historical account

of the origin of the Indian currency system and the ways in which it has been developed to meet the stress of very varying circumstances. And these circumstances have been so specially novel and difficult during the last few years that I think it may be of value to show how what has been done to meet them links on with the past, and what the evolution and recent trend of currency policy in India have been. In doing this I must necessarily survey ground which is familiar to many of you, but a bird's-eye-view is often useful even to those who are thoroughly acquainted with the details of the landscape.

Our currency system in India was founded on that of the Mughal Emperors, whose heritage we gradually took over. Akbar took as a basis of his currency the *rupee* (or silver piece), and this superseded a coin called a *tanka*, which was in its turn linked on to the old Hindu monetary system. Akbar's rupee had a weight of about 180 grains gross and 176 pure silver, and he also issued a variety of gold coins, the commonest of which was worth 10 rupees. The Mughals had many mints, and as their empire foundered, these were increased by the coinages of the now practically independent viceroys of the Hindu States which were emerging from the ruins. In these troublous times the coinage was gradually debased in many local mints until the country was filled with rupees of various different values. The best issues were those of the Murshidabad mint in Bengal, of Lucknow (or Farrukhabad) in Oudh, of Arcot in Southern India, and of Surat on the Bombay side.

The first British mint in India was established in 1671 in Bombay, to provide a local coinage for the island and its neighbourhood, and it is on record that the Emperor Aurangzeb was greatly displeased with the issue by the English of rupees "bearing the name of their impure king."

As the Company established itself as paramount power in India, the four denominations of rupees above referred to gradually replaced the old miscellaneous coinages. The Murshidabad issue, which was the only one that had maintained Akbar's original standard, became the current coin of Bengal and was known as the *sikka* rupee. The Lucknow (Farrukhabad) rupee became the standard for what is now the United Provinces, the Arcot rupee for Madras, and the Surat rupee for Bombay. There were a variety of gold coins current during this time, the most important being the gold mohur (Rs. 15), and the pagoda (Rs. 3½), which up to 1818 was the currency basis in Southern India.

In 1835 a uniform coinage for India was for the first time introduced, and the rupee standard adopted was that of Madras (Arcot), with a weight of 180 grains and containing 165 grains pure silver, a standard which has ever since been adhered to. This rupee was, and is, legal tender without limit, and its weight, one *tola* (a little less than half an ounce), is also the unit on which the Indian standard weights are based. Each rupee is worth 16 annas, and other silver coins were until recently the 8 as. piece which, like the rupee, was legal tender without limit, and the 4 as. and 2 as. pieces which, like the copper coins, were legal tender only up to one rupee. The copper coins were the ½ anna and ¼ anna (there has never been a copper anna piece) and a pie, equal to one-twelfth of an anna.

In 1906, bronze coins were substituted for copper, and a one anna nickel piece was introduced, while quite recently nickel pieces of 2 as., 4 as. and 8 as. have been issued to replace the corresponding silver coins, all these being legal tender up to one rupee only. The recent Exchange and Currency Committee have, however, recommended that if this limit should prove inconveniently low in the case of the 8 as. nickel, it should be raised to Rs. 5 or 10.

The 1835 Act authorised the coinage of various gold pieces. These coins, however, had no independent legal tender value, but were appraised at their market value as compared with the rupee, and presently gold coinage in India fell into complete abeyance.

The normal sterling value of the rupee was taken at 2*s*., *i.e.* it was treated as the equivalent of the British florin.

The mints, which were gradually reduced to two, those now existing at Calcutta and Bombay, were open to the free coinage of silver. Anyone could present silver bullion there and get it coined at a small seigniorage into an equivalent number of rupees. I may mention here that the principal Native States retained their rights of coinage, but these have been gradually surrendered in most cases, a policy which was materially developed by the closure of the Indian Government Mints to the free coinage of silver in 1893, which led, as will be explained presently, to the British rupee rising to a high premium as compared with its bullion value, while the Native States rupees remained on the old bullion footing. At present the most important State which maintains a coinage of its own is Hyderabad, and it had to take measures somewhat analogous to those adopted in British India to keep its rupee above the bullion level.

The supplementing of specie coins by a paper currency was of slow and gradual growth in India. There were always bills of exchange (*hundis*) issued by Indian bankers and *shroffs*, which, if the issuer was a person of accepted reputation, were readily negotiable; but the issue of notes by or on the authority of the State was unknown prior to British rule or in its early stages. By Acts passed between 1837 and 1843 the Presidency Banks of Calcutta, Bombay and Madras were permitted to issue notes payable on demand, but the circulation of these was practically confined to the cities in which they were issued. In 1861 the present note system was initiated; the privilege of note issue was withdrawn from the Presidency Banks and made a State function; and the denominations of the notes to be issued were fixed at Rs. 5, 10, 20, 50, 100, 1,000 and 10,000 (the Rs. 20 note was, however, withdrawn some years ago). For the purpose of this system India was divided into various currency circles, which now have their headquarters at Calcutta, Bombay, Karachi, Madras, Cawnpore, Lahore, and Rangoon, and the notes issued in each circle were legal tender within it and payable on demand at the circle headquarters. In circles other than their own the notes were subject to a slight discount representing the cost of sending them "home" for payment. The object was to obviate the strain which would have been caused at particular centres by free transmission and encashment of notes from other parts of the country; but in course of time it was recognised that to make the smaller notes really popular it was necessary they should be universalised, *i.e.* made payable at any currency centre. This step was taken in connection with the Rs. 5 note in 1903, and a few years later the Rs. 10, 50, and 100 notes were similarly treated. There was, and there is still, no obligation on the part of the Government to encash their notes outside the currency centres, but as a matter of convenience they were to some extent cashed also at local treasuries. I will return to this point later on.

The note circulation began, and at first progressed, in a small way, as was natural in a country which had had grievous experience of political cataclysms and of the debasement of coinage by a succession of Governments, and where the hoarding instinct was, in consequence, strongly developed. In 1870 the total value of the notes in circulation was about $10\frac{1}{2}$ crores of rupees; in 1880 about $12\frac{1}{3}$; in 1890, $15\frac{3}{4}$; and in 1900, $28\frac{3}{4}$.

The encashment of notes was provided for by the establishment of a paper currency reserve, which has played a great part in the problems of recent years, and which was constituted on the English system, *i.e.* a certain amount of the reserve, fixed by legislation from time to time, and representing a portion of the notes outstanding not in the least likely to come in for encashment, was permitted to be held in Government paper; the remainder had to be the exact equivalent in rupees or silver bullion of the balance of the note issue. The invested portion, which was originally fixed at a maximum of 4 crores, had by 1896 been increased to 10, all of which was required to be held in Government of India securities. In 1905 and 1911 a further expansion of 4 crores was permitted, and this was allowed to be held in securities of the United Kingdom.

As regards international exchange, the position was, and still is, that in normal times India exports considerably more than she imports, and there is consequently a large debt owing to her year by year in London, the world's clearing-house for Indian transactions. *Primâ facie* this would have to be defrayed by the export of specie to India, which has, from the time of Pliny on, shown an avid demand for the precious metals; but, on the other hand, India, as represented by her Government, has to make large remittances to London to meet what are called the "home charges"—expenditure in connection with the purchase of stores, material, pension and leave allowances, certain military charges, interest on her sterling debt, and so forth. These were defrayed, to the advantage alike of the Government and trade, by the Secretary of State selling for sterling rupee drafts on the Indian treasuries, a practice which was regularly introduced in 1862, though it had been carried out intermittently for some thirty years previously. These sales ere long became of weekly occurrence, and were to the highest bidders; but the sterling amounts obtained could not normally exceed the cost of procuring silver and remitting it to India for coinage, since that was an ever open alternative. Consequently, allowing for such minor variations as temporary trade conditions may set up between any two countries, the value of the rupee in sterling was conditioned by the world-ratio of silver and gold, which up to 1873 was fairly constant, and resulted in the Secretary of State's council drafts being sold at rates ranging from nearly 2*s*. per rupee in 1861–2, to nearly 1*s*. 11*d*.

in 1872–3 (I am quoting the average figures for each year).

Up to this latter date the system I have described had worked smoothly and easily; additions to the coinage and note issues took place automatically on presentation of bullion at the mints to be exchanged for rupees or note; and the imports of silver and gold (the latter being in demand for use in arts, ornament and hoarding) was left to private enterprise. In the decade 1865–74 the average annual import of silver was about 6¼ crores of rupees, the bulk of which was passed into the mints, and of gold about 3⅔ crores. The Secretary of State's council drafts were merely for the purpose of meeting his home charges, and trade was left to make its own arrangements for the provision of currency in India in excess of the sums they represented, while the paper currency reserve was confined to its original purpose of providing resources (in India) for the encashment of notes. But in 1873 the commencement of trouble began as the result of the fall in the value of silver as compared with gold, initiated by Germany's silver demonetization, and in consequence the rupee exchange kept dropping till the average rate for 1892–93 was only about 15*d*. This depreciation cannot be said to have materially affected India's foreign trade; indeed, in some cases the low rate stimulated exports; but to the Indian community as represented by the State the results were disastrous. The burden of liquidating the home charges was greatly increased, the Indian budgets were constantly dislocated by fresh falls in exchange, and the much-needed investment of British capital in Indian enterprises was checked by the well-founded fear that investors, when they wanted to realise their money in sterling, would have to do so at a material loss. Efforts were made by the Government of India to remedy a position which for them was becoming desperate by an international agreement for bimetallism, but these proved unsuccessful, and it became evident that India must act on her own account in the direction of putting the rupee on a basis independent of its bullion value. It was consequently decided, on the recommendation of a committee presided over by the late Lord Herschell, that the Indian mints should be closed to the free coinage of silver, and that this should only be undertaken on behalf of the Government. The object was, of course, to enhance the exchange value of the rupee by giving it a scarcity premium, for the settlement of India's net trade balances would now have to take place mainly through the Secretary of State's council drawings, the old alternative method of sending silver bullion to India for coinage being no longer available. It was hoped that in this way, and by refraining from fresh coinage, the exchange value of the rupee would soon be forced up to 1*s*. 4*d*., the permanent standard which the Herschell Committee had set before them. This method proved, however, to operate but slowly, as the closure of the mints brought large amounts of previously coined rupees out of hoards, and meanwhile the rate of exchange went on falling with the diminishing bullion value of silver, the average figure for the year 1894–5 being only 1*s*. 1*d*., while for 1896–7 it was still somewhat less than 1*s*. 2½*d*. This position daunted even the stout heart of Sir James Westland, the then Finance Member of the Viceroy's Council, and he suggested that it might become necessary to reduce the standard to be aimed at to 1*s*. 3*d*., and to expedite its attainment by melting down large quantities of rupees. Fortunately, events made it unnecessary to consider such a course, for from 1897–98 the effects of the closure of the mints came into full operation, and by 1898–99 the goal had been reached and the rupee, though its bullion value was then only about 10*d*., had been screwed up to an exchange value of 1*s*. 4*d*., which it was to retain, subject to such minor oscillations as are inevitable in any foreign exchange system, for nearly twenty years. Facts thus emphatically disproved the contention of many economists at the time the mints were closed that it would be impossible to maintain such an artificial system, and that the large gap between the bullion and exchange values of the rupee would flood India with counterfeit coin. There was always, of course, the risk of counterfeiting, which had to be carefully looked to; but, as a matter of fact, the counterfeit issues were small and largely of such a crude nature that they were easily detected.

Meanwhile the whole position had been carefully considered by a strong Committee in London under the chairmanship of the late Sir Henry Fowler (afterwards Lord Wolverhampton), himself a former Secretary of State, whose report, presented in 1899, formed the basis of Indian currency policy until the cataclysms produced by the late war made further changes inevitable. One of the Assistant Secretaries on that Committee was my great friend, and the close friend of many of you present to-day, the late Sir Lionel Abrahams.

who thus initiated a close connection with Indian currency and finance which he was to develop subsequently, first as Financial Secretary and then as Assistant Under-Secretary of State at the India Office. For some twenty years our late friend was continuously connected as no one else was with India's financial problems, and she owes an immeasurable debt to the profound knowledge, intuition amounting to genius, industry, and selfless devotion which he gave to her interests. He literally wore himself out in India's service, and his untimely death a few months ago inflicted a loss on the India Office, and through it on India, which may be described in the most literal sense of the term as irreparable.

The Fowler Committee fully endorsed the policy of closing the mints and of maintaining the exchange value of the rupee at 1*s.* 4*d.*, and then proceeded to consider what steps should be taken to make this policy effective. As was inevitable in the circumstances in which they were appointed, the Committee were keenly impressed by the necessity of protecting the artificial value of the rupee from any breakdown which might accrue from over-coinage. Accordingly, while retaining the rupee (and half rupee) as full legal tender, they laid stress on the necessity of encouraging the use of gold in the currency. When the mints were closed it had been notified that sovereigns and half sovereigns would thereafter be received by Government as the equivalent of Rs. 15 and 7½ respectively, and that gold coin and bullion as well as silver would be held in the paper currency reserve as a backing against notes. The Committee now proposed that the sovereign and half sovereign should, *pari passu* with the rupee, be legal tender to an unlimited extent, and that the use of gold as currency should be encouraged by the coinage of sovereigns in India, while fresh rupee coinage, which had been in abeyance since 1893, was not to be resumed till the gold in the paper currency reserve had reached an inconvenient amount. The obligation to give rupees in exchange for sovereigns and half sovereigns was to be maintained, but the converse exchange of gold for rupees was not to be undertaken except as a matter of convenience, in respect of which no obligation would attach. When rupee coinage was resumed, it was recommended that, to guard against the risk of a turn of the tide making the rupee issues redundant and thus weighing down exchange, the profit on coinage, *i.e.* the difference between the actual cost of turning out rupees and their 1*s.* 4*d.* value, should be credited to a special fund, now styled the gold standard reserve, which should be used when necessary to maintain exchange by the issue of gold. The Committee's policy was fully accepted by the Secretary of State, but the scheme of coining sovereigns in India fell through owing, one must frankly say, to the obstructive attitude of the Royal Mint and the home treasury.

In 1899 an Act was passed making sovereigns and half sovereigns legal tender in India at Rs. 15 and Rs. 7½ respectively, and the internal ratio thus prescribed was the only statutory endorsement of the 1*s.* 4*d.* rupee. The gold standard reserve was constituted in 1901, but has never been on a statutory basis; while in 1898 an Act had been passed permitting the issue of notes against gold deposited in London (as well as in India) and held there as part of the paper currency reserve. The provisions of this Act, though at first temporary, were subsequently made permanent, and permitted the purchase of silver bullion for coinage in India out of the paper currency gold in London and the holding of such bullion, pending its coinage, as part of the reserve.

The system thus initiated was in effect a sort of local bimetallism. It is somewhat confusing, as is sometimes done, to speak of its having reduced the rupee to the position of a token coin, for the essence of an ordinary token coinage, such as our British silver pieces, is that it is only legal tender up to a very limited amount, whereas the rupee's legal tender functions are unlimited. The system provided adequately for the safeguarding of a situation in which the bullion value of the rupee was less than its exchange value. But if the bullion value of the rupee were to exceed 1*s.* 4*d.*, a position which may be taken as arising when the price of silver exceeds 43*d.* per ounce, the system, as events have proved, was bound to need reconsideration. At the time it was framed, however, this was not regarded as a practical possibility; indeed, when I assumed office as Finance Member in 1913, while I recognised that I might on occasion be caused anxiety over the maintenance of the rupee at 1*s.* 4*d.*, I never dreamed that a time was approaching in which one's preoccupation would be to keep it from soaring unduly above that level.

I remarked just now that the closure of the mints prevented the defrayal of a trade balance due to India, in so far as this could not be met through the Secretary of State's council draw-

ings, by the previous method of sending out silver to be coined into rupees. It was now possible to defray this balance by sending out gold, but to do this to a full extent would have caused embarrassment to the London money market, while it would have been inconvenient to India, which was not ripe for a gold currency of any large extent; and as most of the sovereigns and half sovereigns that came out were tendered to Government in exchange for rupees or notes, the paper currency reserve would have been unduly clogged with gold. A trial of paying Government obligations in gold was made in 1898, but had to be withdrawn by reason of its unpopularity. I remember asking one of my Indian clerks at the time how he liked the new system, and he replied: "Not at all, sir; formerly my wife used to let me keep some of the rupees I got, now she takes all the sovereigns for ornaments." The Government of India had originally estimated that a gold holding of more than £5,000,000 in the paper currency reserve would be inconvenient, and this sum was materially exceeded in 1900, necessitating the resumption of rupee coinage. Accordingly, it was decided that the Secretary of State should expand his council drawings, as far as possible, to meet the demands of trade, and in 1898 he notified that he would sell telegraphic transfers on India without limit at 1*s*. $4\frac{5}{32}$*d*. This notification underwent various modifications, but in 1904 it was stereotyped into a policy of selling ordinary councils without limit up to 1*s*. $4\frac{1}{8}$*d*. and telegraphic transfers at an analogous rate,* which in effect prevented the rupee rising materially above 1*s*. 4*d*. And in 1905 the supplementary step was taken of diverting, when this seemed expedient, the transfer of gold from Egypt and Australia to India by issuing telegraphic transfers against the deposit of such gold to credit of the India Office in London. This system was convenient as reducing what would otherwise have been an embarrassingly large export of gold to India, while the rates fixed did not preclude the sending out of such gold in considerable quantities. But it was sometimes worked by the India Office in a way that caused much embarrassment to the Government of India by depletion of their rupee stocks, for the Secretary of State's councils had to be met at once, but some time had to elapse before fresh silver could be procured and coined, while, as a matter of fact, new coinage had to be undertaken on a large scale in most years between 1900 and 1914. To tide over this delay in getting silver and coining it, various expedients were adopted, which culminated in 1906 in a portion of the gold standard reserve being held in India, in the shape of 6 crores of coined rupees, to meet emergencies.

As the gold standard reserve was gradually built up from profits of coinage in India, it was transferred to London (save for the silver portion just referred to), at first by actual remittance of gold but subsequently through council drafts by the Secretary of State against the gold standard reserve. The funds thus obtained were invested in Government securities, British and Imperial, so that the reserve might increase by the payment of interest thereon. In 1907 the Secretary of State, on the report of a Committee presided over by Lord Inchcape in connection with Indian railway finance, directed that half the profits of coinage should thereafter be diverted to the financing of capital railway expenses; but this policy met with much opposition and was suspended in 1909. Since then all profits and coinage have continued to accrue to the gold standard reserve.

In 1905 it was decided that the Secretary of State should normally hold in London a portion of the paper currency reserve amounting to about £5,000,000, to be applied when required to the purchase of silver for coinage, so as to facilitate such purchases.

In 1907 and 1908 there was difficulty in connection with the maintenance of the rupee at 1*s*. 4*d*. A world monetary stringency, aggravated by a failure of crops in India which cut down her exports, seriously threatened exchange. The Secretary of State's council drafts had to be suspended, and after a period of what must be frankly described as fumbling by the then Government of India with a quite unfamiliar situation, they resorted to a remedy urged on them by the India Office, and met the position by the issue of what have since been known as reverse councils, viz., the sale in Calcutta of drafts on London at a rate of 1*s*. $3\frac{29}{32}$*d*., representing roughly the 1*s*. 4*d*. standard, less the cost which would have been incurred by actual remittance of gold to maintain it. To meet these drafts, which amounted to about £8,000,000, the Secretary of State had to draw that amount from the gold standard reserve by selling out securities, the amount so drawn being added in rupees to the reserve in India.

* *Per contra*, the Secretary of State refrained in practice from selling councils when he could only do this at less than 1*s*. $3\frac{29}{32}$*d*.

Since then it has been fully realised that conditions threatening to lower the exchange value of the rupee should be primarily met in this way. In all, including drawing by the Secretary of State on the paper currency gold in London and some temporary borrowing in order to make up for the suspension of his council drafts, this crisis caused a drain on sterling resources to the extent of about £18,000,000. The crisis subsided towards the close of 1908, and it was not long before the expansion of Indian trade balances enabled the Secretary of State to replenish the gold standard reserve in London by council drafts against the amounts which had accumulated in India, while fresh rupee coinage was also resumed on a large scale in 1912–14.

This necessarily brief *résumé* will show how far India had travelled during the twenty years subsequent to the closure of the mints. The Government had now the sole responsibility for additions to the rupee coinage, and were forced, always reluctantly, into making such additions on a large scale by the prosperity of India and her demands for currency. During the fifteen years ending with 1913–14 the net absorption of rupees by the public in India, which had to be met in the main by fresh coinage, amounted to about ninety crores, while the note circulation had at the same time risen from about twenty-eight crores to sixty-six. The Secretary of State's council drawings had expanded to supply the demands of trade, and could no longer be confined to what the Government of India could meet from its treasury balances. Large drawings were often made against the paper currency reserve, with the result of setting free rupees from that reserve in India and replacing them by gold in London, which in turn was largely utilised to produce silver for fresh coinage. The gold standard reserve was being constantly added to by the profits on such coinage, and the interest obtained from its investment and, as was recognised in the currency crisis of 1907–8, it was to be utilised in times of adverse exchange in meeting reverse councils. And the sums accruing to this reserve in India, normally through profits on coinage and exceptionally through reverse council sales, were eventually drawn to London by the Secretary of State's council drafts. The paper currency and gold standard reserve were thus intimately connected, and both had holdings in India and England. The normal location of the paper currency reserve was, of course, in India, but, as has been seen, the Secretary of State usually held a sum of about £5,000,000 in London, and this holding was regarded as a first line of defence against exchange troubles. On the other hand, while the normal *habitat* of the gold standard reserve was London, the Government of India held a sum of six crores of rupees as a reserve against sudden demands for silver currency.

At the same time there was a large import of gold into India. Most of the sovereigns and half sovereigns thus imported found their way primarily into the paper currency reserve in exchange for rupees or notes, but a material portion was subsequently absorbed by the public. Thus, in the twelve years ending with March 1913 this absorption for all purposes —melting, hoarding and circulation—amounted to £60,000,000, and in the same period the gold held in the paper currency reserve in India had expanded from £5,750,000 to £19,500,000. These facts are important as showing the extent to which the demand for silver was supplemented by that for gold. As regards the actual use of gold in circulation, after the failure of the 1898 experiment of trying to force this on, the public were left to their own choice, and there was a considerable use of sovereigns in the Bombay Presidency, the Punjab, and the United Provinces, though rather as a substitute for notes than for actual rupees.

In 1913 there was a good deal of criticism, on the whole much more emphatic than well-informed, of the large balances which were accumulating in London through the Secretary of State's heavy council drawings and of the alleged lending out of these at unduly favourable rates to certain London banks; and a Royal Commission was appointed, under the Chairmanship of Mr. Austen Chamberlain, to investigate these matters and inquire into the general working of the currency system. The Commission presented a valuable report in 1914, in which they gave general approval to the system in vogue, and stated at the outset that the establishment of the exchange value of the rupee on a stable basis was of the first importance to India. They indicated, however, various directions in which they thought the time had come for further amendment of procedure. The findings which have special bearing on our subject to-day were as follows: As experience had shown, a gold standard could be obtained without an active gold currency, and it would not be to India's advantage to encourage the use of gold in internal circulation. Rupees and notes were preferable currency *media*, but the people of

India were entitled to such form of currency as they demanded, even though this should be gold. It might be desirable also, mainly for sentimental reasons, that there should be coinage of sovereigns and half sovereigns in India. To meet periods of weak exchange there must be strong gold reserves actual or potential, and no present limit should therefore be placed on the expansion of the gold standard reserve, which should hold a considerable portion of its assets in actual gold, while its silver branch should be abolished. The gold standard reserve should be located in London, and the Government of India should definitely undertake to call it into play when necessary by notifying that they would sell reverse councils at 1*s.* $3\frac{29}{32}$*d.* to the full extent of their resources when asked to do so. The paper currency system should be made more elastic by regulating the fiduciary portion of the paper currency reserve with reference to the actual note circulation, *i.e.* the maximum amount investible should be fixed as a percentage of such circulation, and a commencement should be made in this direction by increasing the existing investment limit of fourteen crores to twenty. The encouragement of the note circulation was a primary necessity, and to this end facilities for encashment should be increased and the Rs. 500 note universalised. The sale of the Secretary of State's council bills should be primarily for the purpose of financing his own requirements, whether for expenditure or in order to transfer to London funds appertaining to the gold standard reserve, or a portion of the paper currency reserve actually or prospectively needed for the purchase of silver. By drafts on this scale reasonable assistance would be given to trade, but it could not claim more than this.

The Commission did not commit themselves on the subject of the supersession of the Indian Presidency Banks by a single State or central bank, which formed the subject of an interesting memorandum by one of the members, Mr. J. M. Keynes, but recommended that this matter should be separately considered later on. And the amalgamation of the Presidency Banks into one great central institution is now about to take place.

Soon after the Commission's report had been published the war broke out, and full consideration of the proposals made had necessarily to be deferred till the skies cleared. And by that time the situation was so materially different that it was necessary to appoint another Committee, whose work we shall come to later on, to deal with the altered state of things.

I now come to the effects which the war had on the currency and exchange system, which it subjected to a period of great and prolonged stress, as to which I can speak with feeling, since it fell to me as Finance Member to deal with the many difficulties of an ever-changing situation. And in tracing the currency history of these years I must necessarily traverse much the same ground as that covered by the first portion of the report of the recent Exchange and Currency Committee.

When the war broke out, India was fortunately in a strong financial position. The treasury balances were high and so were the gold holdings in the paper currency reserve, which amounted in July 1914 to about £12,000,000 in India and £6,000,000 in London. The total assets of the gold standard reserve were over £25,000,000, of which about £5,000,000 were held in gold, besides a considerable amount in short time securities which were about to mature.

The outbreak of war led to a business and exchange panic, which was reflected in a run on Post Office Savings Bank deposits and on the encashment of currency notes. The exchange situation was promptly dealt with by the application of the reverse councils remedy, it being notified that the Government would until further notice sell "reverses" up to £1,000,000 a week, and would support exchange to the full extent of its resources. Provision was at the same time, made for the necessities of immediate remittance by selling telegraphic transfers as well as ordinary bills. Between August 1914 and January 1915 the sale of reverse councils amounted to £8·7 million, to which must be added a further sum of nearly £5,000,000 in the official year 1915–16, when there was a temporary recurrence of exchange weakness; after that there were no exchange difficulties of the old character. The gold standard reserve was strengthened by the abolition of the silver branch, as recommended by the Chamberlain Commission, and the equivalent credit to it of £4,000,000 from the paper currency gold in India, and such gold was also exchanged for the rupees which accrued to the gold standard reserve through the sales of reverse councils. The issue of gold to the public in exchange for notes or rupees was suspended from August 5th, 1914, having been found to result in an undesirable drain which amounted to nearly £2,000,000 in the four days preceding.

The run on the Post Office Savings Banks

depleted their deposits by about 8 crores, or one-third of the total amount, but from 1915–16 the deposits began to increase again. Here, as in the corresponding run on currency notes, the policy adopted was to restore public confidence by giving full facilities for encashment. In fact, in the case of currency notes, the Government took special steps to see that all demands at district treasuries were promptly met, though legally these need only be honoured at currency centres, and steps were taken in the following year to make this policy, as was then hoped, permanent. The run on the currency notes resulted in a decrease of several crores in the circulation. In July 1914 the gross note circulation was about 75½ crores, and the net circulation (deducting the amounts held by Government in its reserve treasuries) about 66¼ crores. In March 1915 these figures had shrunk to about 61½ and 55½ crores respectively, and the old position was not re-attained till July 1916. These drains on the resources of Government, accompanied by stoppage of the Secretary of State's council drawings while exchange was depressed, necessitated a temporary loan of about £7,000,000 from the portion of the gold standard reserve then in India, and a like borrowing through India bills in London, but these sums were ere long repaid. The initial difficulties caused by the war had thus been successfully met, and those which were presently to come upon us were of an entirely different character.

For the five pre-war years ending with 1913–14, Indian trade had been in a very prosperous condition, the excess of merchandise exports over imports amounting on the average to £52,000,000 a year, of which £24,000,000 were met outside the Secretary of State's councils by imports of specie on private account. These thus totalled £120,000,000 for the quinquennium, of which no less than £96,000,000* (on the average about £19,000,000 a year) were in the shape of gold coin and bullion.

During the first two war years Indian trade suffered from the stoppage of relations with enemy countries and other dislocations, and the average excess of exports of merchandise over imports fell to about £31,500,000. But in the three following years the growing demands for Indian products, and the curtailment of imports following on the demands for war purposes on the products of Great Britain and her Allies, brought the average excess of Indian exports over imports to nearly £60,000,000 a year. At the same time the old method of meeting a large part of this balance in the shape of gold had become impracticable, owing to the necessity which the belligerent Governments felt for conserving their gold resources, and in the three years ending 1916–17 the total net imports of gold coin and bullion into India averaged less than £4,000,000 a year, while the private imports of silver for the same period averaged about £2⅔ million only owing to conditions which materially restricted the amounts available for private acquisition. Briefly, these were the falling off of the world's production of silver owing to the anarchic conditions of Mexico, the increased demand for silver coinage set up by the war in various countries, and the consequent rise in price. The result was that the burden of defraying India's trade balances fell more and more heavily on the Secretary of State's council drawings, while the absorption of rupees thus set up was enhanced by the fact that, as the war went on, India was taking an ever-increasing share in financing outlay for military purposes within her own borders and also outside of them, *e.g.* in Mesopotamia, East Africa and Persia. Of the amounts thus expended between 1914–19, about £240,000,000 in all were recoverable from His Majesty's Government, on whose behalf the outlay had been undertaken, but their repayments were made to the Secretary of State in London, and circumstances precluded his remitting more than a small portion out to India in the shape of silver purchases. Heavy rupee credits had also to be given to facilitate American purchase of Indian produce and other analogous arrangements. A situation was thus reached in which the Indian home balances were very large, while those in India itself were subject to constant strain and diminution, and the Government of India were often at their wits' end to devise means for meeting the liabilities cast upon them. They must indeed have failed to do so but for the fact that their large money disbursements in connection with the war were partly counterbalanced by receipts from local borrowings on a scale which was colossal as compared with the amounts they had formerly looked to obtaining from the Indian money market. About 130 crores of rupees were raised in this way between 1917–19, and though this was primarily for the purpose of paying the war contribution of £100,000,000 which India had proffered to the home Government as a free gift in 1917, the adjustment with

* The sterling figures are calculated at the then prevailing rate of 15 rupees to the £.

them was through the Secretary of State's home transactions so that the immediate loan proceeds were available for Indian purposes. Treasury bills, a new feature of Indian finance introduced in 1917, also fetched a net amount, up to November 1919 of over 65 crores. The resources of the Indian Government had likewise been added to by increases of taxation (though these were primarily for revenue and not for currency purposes) effected in 1916 and 1917, while throughout the war ordinary capital outlay on railways, etc., was limited to what was absolutely necessary.

The factors I have just sketched out did not, of course, come into full play for some time; but by February 1916 it became evident to the Government of India that large purchases of silver for coinage would be required to meet the absorption of rupees that had set in, and which would increase with the demands set up by the special circumstances above indicated. The Secretary of State did his best to give help in this direction, and in 1916–17 and 1917–18 was able to purchase about 200 million ounces in the open market, a figure which exceeded the world production of silver for any year since 1913. This demand on silver naturally caused its price to rise. In 1914 the highest London price had been 27¾*d.* per oz., and 1915 showed much the same result; but by December 1916 the price was up to 37*d.*, and in June 1917 to 40*d.*, a dangerous approximation to the 43*d.* at which the cost of providing new rupees would begin to exceed 1*s.* 4*d.*

The demands for rupees were already necessitating a curtailment in the metallic portion of the paper currency reserve, which was authorised in increasing proportion by a series of temporary enactments, commencing in March 1916 with the application of the Chamberlain Commission recommendation that the fiduciary portion of the reserve should be increased, initially, to twenty crores, and the additional six crores were invested in British Treasury Bills. Further and later investments were also in Treasury Bills as the best equivalent to the gold that was no longer available. By December 1916 the Secretary of State's heavy council drawings to meet trade demands gave rise to serious apprehension on the part of the Government of India, whose rupee holdings in the paper currency reserve were then only fourteen crores, and at our earnest request he gave up the system of unlimited sales at 1*s.* 4¼*d.*, and limited his council drawings week by week to amounts, which in practice varied from 130 down to 120 lakhs, fixed with reference to our rupee resources, the rate at which he sold being 1*s.* 4¼*d.* for immediate telegraphic transfers. This measure met with considerable complaint at the time from trade interests, but was absolutely necessary to avoid inconvertibility, which would have been a most serious disaster for India politically as well as economically, and would have been regarded throughout the country as a repudiation by the Government of its note obligations and as indicating its financial and moral bankruptcy.

This great change made it necessary, in the interests of trade, to restrict applicants for the limited amount of councils available to an approved list, which included the exchange banks and some other large purchasers, and to require the grantees of councils to do exchange business with other parties at prescribed rates, and to apply their resources preferentially to the export from India of notified articles of material importance in connection with the war. The exchange banks were at the same time encouraged to finance exports as freely as possible by a guarantee that they would be protected against any possible future loss through the vicissitudes of exchange in respect of the funds they employed, while appeal was made to the mercantile community in India to effect their purchases of sterling through these banks.

In August 1917 the rising price of silver, which had now reached 46*d.* per oz., rendered it necessary to cut loose the rupee from its now traditional 1*s.* 4*d.* mooring, and to raise the price of the Secretary of State's councils to 1*s.* 5*d.* for telegraphic transfers, a figure which had to be further raised to 1*s.* 6*d.* in April 1918 when the silver price per ounce had, under agreement with the American Government, been temporarily stabilised at a dollar. It was announced at the time of the first increase that thereafter the rates at which councils would be sold must be based roughly on the price at which silver could be bought. These steps met with some criticism in India, it being argued, quite wrongly, that they were in contravention of the policy enunciated by the Chamberlain Commission, which had never contemplated a state of things in respect of silver prices such as had now arisen, and that they would play havoc with India's trade. This last prophecy was speedily falsified by events, the fact being that the demand for India's exports was so great that it more than counterbalanced the normal effects of a high exchange, while it was clearly impossible to go on coining rupees at a loss, to stereotype a

situation in which it would become profitable to export rupees from India, or to apply the gold standard reserve, as the critics proposed, to a state of things which it was never intended to meet and which would have completely exhausted its resources. The Government of India and the Secretary of State took these steps with great reluctance, and it is obvious to all who have studied the situation impartially that had exchange been left to unfettered private demand the rupee would have soared to a much higher pitch. The effects of Government control were to keep it down as long as possible.

Meanwhile the absorption of rupees was continuing, and in the summer of 1917 the Government of India addressed a strong representation to the Secretary of State, pointing out that we should drift into inconvertibility if special measures were not taken to avert this calamity. We asked for special gold assistance from His Majesty's Treasury, but this they were not able to afford, and we suggested that steps should be taken to get America to save the situation by the release of part of the large silver reserves stored in her currency vaults. The latter policy was accepted, but negotiations with the United States Government took time and did not finally mature till April 1918, when, thanks to the representations of Lord Reading, most ably seconded by my old friend and former coadjutor in India, Sir James Brunyate, a measure was passed (the Pittman Act) authorising the sale by America to other Governments of up to 350,000,000 silver dollars from the holdings in her reserves. Of this no less than 200,000,000 dollars were allotted to India at a price of 101½ cents per fine oz., which we eventually paid for, partly through the large amount due to us for war expenditure by the British Government, and partly by rupee credits in favour of the Federal Reserve Bank of New York for the financing of American purchases in India. This most welcome supply eventually saved the situation, but in the interim we were in a very parlous state, as the American dollar silver did not begin to come in till July 1918. Meanwhile we had been taking such measures as we could to strengthen our precarious position. In the early part of 1917 we sold gold bullion in India to the value of about £4,000,000, and subsequently released five million sovereigns for the financing of crops, chiefly in the Punjab and Bombay. The difficulty in utilising gold as a substitute for rupees was, however, that as there had been hardly any supplies of gold to the Indian public since the commencement of the war, the sovereign had acquired a scarcity premium materially above its standard ratio of rupees 15. We prepared however, to add to our stock of gold, against future emergencies, by an Ordinance, issued in June 1917, requiring all gold imported into India to be sold to Government at a price based on the exchange value of the rupee. By this means we obtained the greater part of the gold imports of 1917–18, which amounted in all to over £14,000,000, and came in from Japan and America by reason of the difficulties those countries had of obtaining rupee exchange. But in the following year the import came to a standstill owing to restrictions placed on the export of gold from the United States. About the same time we declared the use of silver and gold coins for other than currency purposes to be illegal, though the prohibition was one very difficult to enforce; and in September 1917 we prohibited the import of silver into India on private account as tending to interfere with the Secretary of State's purchases, and declared the export of silver coin and bullion illegal, to guard against the temptation to such export through the bullion value of the rupee exceeding at any time the exchange value. Further, in December 1917 and January 1918, we issued small notes of the value of Rs. 2½ and 1 respectively with the hope that the use of these would diminish the demand for rupees. This experiment did not at first meet with rapid success, but in little more than a year the circulation of these notes (chiefly in the R. 1 issue) exceeded twelve crores.

We continued to economise our rupee holdings by larger investments in the paper currency reserve; but in spite of all these expedients our silver balances had fallen in March 1918 to less than 10½ crores, a figure which would have been considered absolutely unsafe before the war. Then bad news from the Western Front led to a run on notes. By the end of April we had only 7½ crores of silver left, and in the first week in June no more than four. Inconvertibility seemed inevitable, but we did all that was possible to avert it, sending, for instance, a war vessel to Hong Kong to bring over from there a considerable amount of silver which the Secretary of State had procured for us from America. We withdrew most of the facilities previously granted for the encashment of notes at district treasuries and reverted to our former legal obligation to meet these at currency centres only, while to relieve the pressure there we prohibited the transport of specie on private account by rail or steamer, or its transmission

through the post. As the recent Committee justly observe, the result of these restrictions was the substitution of notes for rupees to a large extent as a currency medium, and by November 1919 the note circulation had risen to nearly 180 crores. We obtained the sanction of the home Government to the establishment of a branch of the Royal Mint at Bombay for the coinage of sovereigns, so as to be able to utilise our gold bullion instead of having to send this to Australia to be coined, and pending its establishment (in August 1918) we used our own mints to turn out a local gold piece of the value of Rs. 15, styled a gold mohur, which one of my colleagues facetiously corrupted into "the gold Meyer." And during the spring of 1918 we issued sovereigns and mohurs to the extent of nearly £6,000,000 for the financing of crops, mainly in the Punjab. These issues did not remain in circulation, the scarcity value of the gold coins being now so large as to induce the recipients to hoard or melt them; but the measure achieved its immediate object, which was to gain time by diminishing the strain on our scanty silver stocks.

From July 1918 the position mended with the arrival of silver from America, and the total importation for the year 1918–19 amounted to about 106,000,000 ounces obtained by the Secretary of State, and over 150,000,000 ounces from the Pittman dollars (the remainder of these arrived in the following year). But although we had just escaped inconvertibility, it took some time before we were in an assured position, and I used anxiously to scan weekly returns of the steamers under way, the amounts of silver they were carrying, and the dates on which they might be expected to arrive. When I quitted office in November 1918 our silver stocks in the paper currency reserve—which by an Ordinance passed in the previous April could be made to include all silver held for us in America or in transit thence—amounted to about 10½ crores of coined rupees and 19½ crores of bullion, while by November 1919 the silver stocks amounted in all to about 47½ crores.

Subsequent difficulties have been mainly in connection with the ever-increasing price of silver. We have already seen that in April 1918 the exchange value of the rupee had had to be raised to 1*s.* 6*d.* For about a year after that silver prices remained fairly constant, owing to strict control over private exports by the United States Government and Canada, and the fixation by the British Government of a maximum price which followed the American one of 101½ cents per ounce. But in May 1919 these controls were withdrawn, and the price of silver at once soared, pushed on by heavy demand from China, and necessitating an exchange rate of 1*s.* 8*d.* Another important factor now came into play. The basic silver values are dictated by the conditions of the American market and the dollar prices quoted there, while as the bulk of India's exchange transactions are through London, and the silver she requires for coinage has to be purchased by the Secretary of State, the dominant factor here is the London sterling price. In normal conditions, however, this distinction is of no practical importance, and until after the close of the war special measures were taken by His Majesty's Government to maintain sterling-dollar exchange at almost its full normality. But in May 1919 it was decided that such special control was no longer necessary, and that the course of Anglo-American exchange should be left to natural conditions. The heavy debts due to America from Europe, for which Great Britain is to a large extent an exchange clearing-house, and the impossibility in present conditions of meeting the demands for American products by counter-exports, caused the exchange to fall rapidly against sterling. In normal times the pound is worth about $4.87. In December 1919 it only fetched $3.83, and at the time I write it is about $3.67, having previously been lower still. These circumstances led to the sterling price of silver being materially in excess of the gold-dollar value and to a rapidly increasing rupee exchange. In August 1919 the Secretary of State had to fix this minimum rate for immediate telegraphic transfers at 1*s.* 10*d.*; in September, at 2*s.*; in November, at 2*s.* 2*d.*; and in December, at 2*s.* 4*d.*

Fortunately, it was not necessary to purchase fresh silver on behalf of India during these months, as she became once more able to acquire gold. In June 1919 the American Government removed its previous embargo on gold exports, and His Majesty's Treasury, which had been very nervous during the war as to a drain of gold by India, now consented to the Secretary of State acquiring what he could for the Indian Government. Between August and November 1919 some 467,000 fine ounces (an ounce would produce 4¼ sovereigns) were obtained in New York by temporary sales there of telegraphic transfers on India to provide rupees required for the financing of American trade; about 2,500,000 ounces were purchased by the Secretary of State in London, the United States and

Australia; and private imports, which were encouraged by notifying that the Government would take them over at a price which made allowance for the difference between gold and sterling values, brought in nearly 350,000 ounces. The last paper currency return I have available shows that this includes, against a gross circulation of 183 crores, silver coin and bullion to the value of 39 crores and about £30,500,000 in gold, actually in India or in transit thereto.

Efforts have been made to pass some of the gold acquired into the possession of the public in India and thereby to diminish the previous scarcity value of the sovereign. Since September last there have been fortnightly sales of gold bullion, the amount sold up to the end of November being the equivalent of about 3½ million sovereigns, and these sales, which still continue, have materially reduced the premium in question.

I may note here that after the conclusion of the war it was no longer necessary to take special measures for the financing of particular Indian products from the Secretary of State's council sales, or to confine these to a limited number of approved bidders. The old system was therefore reverted to, with the important modification that the total weekly sales continued to be limited to what the Government of India could conveniently meet from time to time, while a limit was also placed on the amount which could be applied for by any one applicant.

(*To be continued.*)

GENERAL NOTES.

Sericulture in France during 1919.—According to an official statement recently published by the *Office des Renseignements Agricoles*, the rearing of the silkworm in the nineteen Departments where this industry was carried on occupied no fewer than 52,401 persons. The quantity of "grain" (silkworms' eggs) incubated was 65,983 lots of 25 grams (nearly an ounce) each, of which 63,277 lots were of French, and 2,676 lots of foreign origin. The total production amounted to 2,671,623 kilogs of cocoons (*cocons frais*), that is to say live ones. This gives an average of about 40½ kils., or about 88 lb. per ounce of 25 grams of seed hatched. The average price per kilog of cocoons was 7·53 francs for cocoons for spinning and 7·85 francs for reproduction of eggs. The total amount realised by sale of cocoons was 20,121,402 francs.

National Thrift.—The House of Commons has passed the second reading of a Government Bill to withdraw all restrictions made in the Act governing savings and trustees savings banks in respect to the limits applicable to depositors and holders of stock. Hitherto deposits have been limited to £50 in one year and a total sum of £200. In the case of investments in Government stock the respective limits have been £200 and £500. The special war regulation removing the limit on deposits ceases to have effect within six months after the end of the war. The Bill also provides for the changing of the name of the "War Saving Certificates" to "National Savings Certificates," and sanctions an increase in the allowance.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

May 5.—Dr. C. E. Kenneth Mees, "A Photographic Research Laboratory." Sir Henry Trueman Wood, Chairman of the Council, will preside.

May 12.—Graily Hewitt, "Rolls of Honour." Halsey Ricardo, F.R.I.B.A., will preside.

May 19.—John Somerville Highfield, M.Inst.C.E., M.I.E.E., "Electrical Osmosis." Alan A. Campbell Swinton, F.R.S., will preside.

Indian Section.

Thursday afternoon, at 4.30 p.m.:—

May 20.—Brigadier-General Lord Montagu of Beaulieu, K.C.I.E., C.S.I., "Roads and Transport in India."

Monday afternoon, at 4.30 p.m.:—

May 31.—Albert Howard, C.I.E., M.A., A.R.C.S., F.L.S., Imperial Economic Botanist to the Government of India, "The Improvement of Crop Production in India." Sir Robert W. Carlyle, K.C.S.I., C.I.E., will preside.

Friday afternoon, at 4.30 p.m.:—

June 18.—Sir Valentine Chirol, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

Indian and Colonial Sections.

(Joint Meetings.)

Friday afternoons, at 4.30 p.m.:—

May 28.—Professor William A. Bone, D.Sc., Ph.D., F.R.S., "Lignite."

June 4.—Professor Sir John Cadman, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E., "The Oil Resources of the British Empire."

Cantor Lectures.

Monday evenings, at 8 p.m.:—

Arthur Thomas Bolton, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and

Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.

Syllabus.

LECTURE I.—MAY 3.—The first lecture deals with the general position in English architecture at the time of Robert Adam's return from Italy in 1758, and describes the revolution of taste that he brought about. The leading ideas of his scheme of architecture and decoration, now known as the Adam style, are fully discussed.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 3 ... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. A. T. Bolton, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758-1837." (Lecture I.)

Farmers' Club, at the Surveyors' Institution, 12, Great George-street, S.W., 4 p.m. Professor D. A. Gilchrist, "Best Methods of Laying Down and Improving Grass Land."

Royal Institution, Albemarle-street, W., 5 p.m. General Monthly Meeting.

Engineers, Society of, at the Geological Society, Burlington House, W., 5.30 p.m. Mr. W. G. Cooke, "The Assessment of Engineering Undertakings."

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. F. G. Donnan and J. I. Orme Masson, "The Theory of Gas-Scrubbing Towers with Internal Packing." 2. Messrs. P. F. Frankland and A. F. Garner, "The Preparation of Picryl Chloride." 3. Messrs. P. F. Frankland, F. Challenger, and Miss D. Webster, "The Preparation of Thiocarbonyl Tetrachloride."

Geographical Society, 135, New Bond-street, W., 8.30 p.m. Mr. H. St. J. Philby, "Across Arabia: from the Persian Gulf to the Red Sea."

TUESDAY, MAY 4 ... League of Nations Union, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 6.30 p.m.

Anglo-Russian Literary Society, Imperial Institute, South Kensington, S.W., 3 p.m. Mr. W. B. Steveni, "The Republics of Old Russia."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. Keith, "British Ethnology—The Invaders of England." (Lecture II.)

Alpine Club, 23, Savile-row, W., 8.30 p.m.

Röentgen Society, at the Medical Society, Chandos-street, W., 8.15 p.m. Professor S. Russ, "Some Problems in the Action of Radiation upon Tissue."

WEDNESDAY, MAY 5 ... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Dr. C. E. Kenneth Mees, "A Photographic Research Laboratory."

British Academy, at the Royal Society, Burlington House, W., 5 p.m. Sir Reginald Blomfield, "The Tangled Skein: Art in England, 1800 to 1920."

Geological Society, Burlington House, W., 5.30 p.m.

Public Analysts, Society of, at the Chemical Society, Burlington House, W., 8 p.m. 1. Mr. C. A. Mitchell, "Estimation of the Age of Ink in Writing." 2. Mr. E. R. Dovey, "Estimation of Chinese Crude Camphor." 3. Messrs. H. D. Richmond and L. R. Ellison, "Studies in Steam Distillation, Part 7: The Volatility of Isomers."

Automobile Engineers, Institution of, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. Major B. H. Thomas, "Electro Deposition of Iron as applied to Motor Vehicle Repair Work."

Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. A. Vallance, "Figure Sculpture, Painted Glass, and Mediæval Decoration."

University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Mr. A. Safwat, "Bahaism."

THURSDAY, MAY 6...Post Office Engineers, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.45 p.m.

University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 6 p.m. Dr. S. Ahmad Khan, "The Development of Modern Educational Institutions in India." (Lecture I.)

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. 1. Dr. G. P. Bidder, (*a*) "Notes on the Physiology of Sponges"; (*b*) "*Pandorina spongiarum*, a new species of Alga found in a Sponge." 2. Mr. E. J. Bedford, "The British Marsh Orchids and their Varieties, illustrated by coloured drawings and lantern-slides."

Chemical Society, Burlington House, W., 8 p.m. 1. Mr. G. M. Bennett, "The mustard-gas problem." 2. Mr. C. K. Ingold, "A new method of preparing muconic acid." 3. Messrs. J. W. Cook and O. L. Brady, "The dinitration of *m*-acetotoluidide." 4. Messrs. Y. Venkataramayya and M. V. Narasimhaswamy, "A new ozonizer." 5. Messrs. G. T. Morgan and H. D. K. Drew, "Orthochlorodinitrotoluenes." (Part I.)

Royal Institution, Albemarle-street, W., 3 p.m. Mr. R. C. Thompson, "The Legends of the Babylonians." (Lecture II.)

Iron and Steel Institute, at the Institution of Civil Engineers, Great George-street, S.W., 10 a.m. 1. Annual Meeting. 2. Inaugural Address by the President. 3. Mr. E. H. Lewis, "Iron Portland Cement."

2.30 p.m. 1. Mr. F. Clements, "British Blast Furnace Practice." 2. Mr. H. E. Wright, "Chemical and Thermal Conditions in Blast Furnace Practice." 3. Mr. C. H. Ridsdale, "The Valuation of Ores and Iron Making Material." 4. Mr. J. A. Heskett, "The Utilisation of Titaniferous Iron Ore in New Zealand."

FRIDAY, MAY 7...Anglo-Batavian Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.45 p.m.

Iron and Steel Institute, at the Institution of Civil Engineers, Great George-street, S.W., 10 a.m. 1. Mr. C. A. Ablett, "Direct Current compared with Three-Phase Current for Driving Steel Works Plant." 2. Mr. J. F. Wilson, "Notes on Slag Conditions in Open-Hearth Basic Steelmaking Practice." 3. Messrs. B. Yaneske and G. A. Wood, "The Reduction of Silicon from the Slag in the Acid Open-Hearth Process."

2.30 p.m. 1. Mr. W. E. Hughes, "Some Defects in Electro-deposited Iron." 2. Messrs. T. Baker and T. F. Russell, "Note on the Ball Test." 3. Mr. J. H. Whiteley, "The Distribution of Phosphorus in Steel between points Ac1 and Ac3." 4. Mr. G. F. Preston, "Practical Notes on the Design and Treatment of Steel Castings."

Royal Institution, Albemarle-street, W., 9 p.m. Lord Rayleigh, "The Blue Sky and the Optical Properties of Air."

Philological Society, University College, W.C. 8 p.m. Anniversary Meeting.

China Society, at the School of Oriental Studies, Finsbury-circus, E.C., 5.30 p.m. Mr. G. S. Boulger, "The History of Silk."

SATURDAY, MAY 8...Royal Institution, Albemarle-street, W., 3 p.m. Dr. F. Chamberlain, "The Private Character of Queen Elizabeth." (Lecture II.)

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, MAY 10th, at 8 p.m. (Cantor Lecture.) ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758-1837." (Lecture II.)

WEDNESDAY, MAY 12th, at 4.30 p.m. (Ordinary Meeting.) GRAILY HEWITT, "Rolls of Honour." HALSEY RICARDO, F.R.I.B.A., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, May 3rd, Mr. ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, delivered the first lecture of his course on "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758-1837."

The lectures will be published in the *Journal* during the summer recess.

NINETEENTH ORDINARY MEETING.

WEDNESDAY, MAY 5th; SIR HENRY TRUEMAN WOOD, Vice-President and Chairman of the Council of the Society, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Bixby, William Keeney, M.A., LL.D., St. Louis, Missouri, U.S.A.
Bowden, John, Chorlton-cum-Hardy, Manchester.
Christie, Edward William, London.
Cleveland-Stevens, Edward Carnegie, M.A., D.Sc. (Econ.), London.
Cravath, Paul D., A.M., LL.B., New York City, U.S.A.
Davies, Thomas Bertram, Durban, Natal, South Africa.
Grieve, Norman William, London.
Gross, Alexander, F.R.G.S., London.
Kerr, Henry Farquharson, New York City, U.S.A.
Norrington, George Frederick, Wilmslow, Cheshire.
Perry, Mrs. Thos. Sergeant, Boston, Mass., U.S.A.
Reed, Harry E., Swansea.
Richards, Captain James Charles, Assoc.Inst.N.A., Bombay, India.
Summers, Albert Victor, Cheadle Hulme, Cheshire.
Thomas, David Idwal, M.Inst.M.E., Porth, Wales.

The following candidates were balloted for and duly elected Fellows of the Society:—

Birrell, William, Loughborough.
Dobbs, Ernest John, Birmingham.
Walker, W. Ralph, J.P., Lochgilphead, Argyll.

A paper on "A Photographic Research Laboratory" was read by Dr. C. E. KENNETH MEES.

The paper and discussion will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

THE INDIAN CURRENCY SYSTEM AND ITS DEVELOPMENTS.

By SIR WILLIAM MEYER, G.C.I.E., K.C.S.I.

(*Continued from page* 393.)

The bewildering sequences of events which I have endeavoured to summarise led to the appointment by the Secretary of State, with the full concurrence of the Government of India, of a very strong Committee on Indian Exchange and Currency, to provide, if possible, definite principles and lines of action for the future in place of the hand-to-mouth expedients which the ever-changing circumstances of the war and its aftermath had hitherto dictated; in short to endeavour to revise the doctrines of the Fowler Committee with reference to the circumstances of a new era in which high and not low prices of silver were the predominating feature. As

stated in the concluding portion of the terms of reference, the primary necessity was to fix on "the policy that should be pursued with a view to meeting the requirements of trade, to maintaining a satisfactory monetary circulation, and to ensuring a stable gold exchange standard." The terms of reference did not include any allusion to the possibility of international bimetallism, the consideration of which would have been quite impracticable at a time when the world's exchanges are in their present chaotic condition.

This Committee, which was presided over by Sir Henry Babington Smith, and of which our Chairman of to-day was *pars magna*, was appointed in May 1919 and reported just before Christmas. The report, which gives a most able and lucid presentment of the difficulties which have arisen and the policy necessary for the future, and which has received the full approval of the Secretary of State as regards the measures immediately necessary, provides what I think is the best policy possible in present conditions, and will always be a classic in the literature of Indian currency. Many of you have, of course, read it, but for the benefit of those who have not, and to refresh the memory of those who have, I propose to give a fairly full abstract of its findings. I may say here, and I am sure our Chairman will agree with me, that I think the Committee were greatly assisted in coming to their final conclusions by the rapid march of events while they were sitting, culminating, as has already been mentioned, in the advance of rupee exchange up to 2*s.* 4*d.*, and the demonstration that large gold supplies were once more obtainable for India.

A most important document which the Committee found before them when they assembled was a memorandum on future policy prepared by the Government of India not long before. In this document the Government of India laid preponderant stress on the necessity, in the interests of trade, of obtaining a reversion to stability of exchange, and of terminating a situation in which this was at the mercy of spasmodic increases necessitated by the progress of silver prices. They aimed, therefore, at obtaining a permanent rate of exchange at a figure which they left it to the Committee to fix, though it seems clear that they hoped that this would not materially exceed the 1*s.* 8*d.* rate which had then been lately notified; and they proposed that should the price of silver rise to a level which would render the further supply of rupees a matter of loss with reference to the stabilised rate, the Secretary of State should abstain from further purchases, a measure which it was hoped would bring silver down again. At the same time the Secretary of State was to revert to the old system of selling councils without limit to meet the demands of trade. The Government of India recognised that heavy council drawings, combined with a shortage or stoppage of silver supplies, might speedily exhaust their rupee stocks. (They admitted the desirability of enhancing their gold reserve, but evidently did not contemplate a situation in which large supplies of this metal would be available, while in any case they deprecated the use of gold for circulation.) These factors would obviously provoke inconvertibility, which in my time the Government of India had regarded as one of the worst calamities, politically as well as economically, which could befall the country. My distinguished successor, Lord Meston, took a different view, however, and while admitting that inconvertibility would be a serious matter, thought that it ought to be faced if necessary, now that the war was over, in order to secure exchange stability, and comforted himself with the hope that it need only be of short duration if the stoppage of purchases for the Government of India reduced silver prices again. I said at the commencement of this paper that I proposed to abstain from polemical disquisitions, otherwise I should have been tempted to use strong language about what I regard as a most dangerous policy. But I had an opportunity of telling the Committee what I thought of it when I appeared before them as a witness, and I was very pleased to see that in paragraph 41 of their report they condemn the proposal in restrained but emphatic terms. Taking the case merely from the currency point of view, they observe that "the credit of the Government would suffer a severe blow, and if belief in the convertibility of the note were once shaken it might take many years of anxious labour to restore confidence, while the set-back to development of a sound and economical monetary circulation in India would be disastrous."

They were justly sceptical of the Government of India's view that the cessation of the Secretary of State's silver purchases would bring down the price, observing that he had stood out of the silver market in the latter part of 1919 when he could afford to do so by reason of the stocks then in India, but that other demands had nevertheless greatly enhanced prices. They also observed, with reference to an alter-

native suggestion of "partial inconvertibility," under which the encashment of notes at currency centres would be subject to such conditions in respect of amount, etc., as the Government of India might prescribe, that the effect of this on the credit of Government and on popular confidence in the note issue would differ but little from inconvertibility pure and simple. The Committee arrive, therefore, at the (to my mind) most satisfactory *dictum* that "the maintenance of the convertibility of the note issue is a vital part of the India currency system."

The action of the Government of India in this connection has an interesting parallel in that of Sir James Westland in 1898, to which I referred in a previous part of this paper, as regards lowering the exchange standard to 1*s*. 3*d*. and the melting down of the rupee. In both cases the authorities in India gave way to counsels of despair just at a time when events were to prove these unnecessary—in the present instance through the resumption of large gold supplies.

I have dealt with this matter, by reason of its primary importance, a little out of its place in the Committee's findings, but as regards the rest of these I shall follow as far as possible the order in which they are presented in the report from paragraph 33 onwards. The Committee start by recording that the system built up since 1893 worked well and was beneficial to India. Its failure to meet recent circumstances was due to a rise in the price of silver that could not have been foreseen.

As regards stability of exchange, to which the Government of India attached such overwhelming importance, the Committee find (para. 34) that "for the current operations of trade stability is an important facility rather than an essential condition"; and they go on to say (paras. 35 and 36) that "whatever the evils and inconveniences of instability may be, they are increased if the movements of exchange are brought about not by the automatic action of economic causes but by administrative acts," and that the object should therefore be to restore stability to the rupee at as early a date as practicable, and also to restore the automatic working that characterised the Indian currency system in the past." I may note, however, that such full automatic conditions as would result from the re-opening of the mints to free silver coinage are not recommended.

The Committee next consider and condemn, this time in complete accord with the Government of India, a suggestion which has every now and then been made that the exchange value of the rupee might be kept down, without inconvertibility, by the issue of a rupee piece of less bullion value than the present one. As to this they say (para. 38), "the fineness of the present rupee, which is known to every village goldsmith and silversmith, has remained unaltered since 1835, and its use is so firmly rooted in the habits of the Indian people as to have given it the character of a standard weight." Modification of such weight or fineness would "re-act gravely on the credit of the Government, and possibly lead to serious social and economic consequences," while, in accordance with Gresham's law, the old rupees would be driven out of circulation and currency difficulties thus increased. For similar reasons they reject the idea of keeping the rupee on its present footing, but issuing a Rs. 2 or Rs. 3 coin of lower bullion value, or of turning the rupee into a nickel piece, though they fully approve the replacement of silver by nickel in respect of smaller coins.

They then (para. 42) discuss the probability of future variations in the price of silver, and though this is a matter on which prophecy is of course most difficult, they put forward the view that the price per ounce is not likely for some years to come to exceed what would be the equivalent of 2*s*. (gold) per rupee; or to be lower than one dollar, viz., the amount which America will have to pay for the silver which she must procure, under the Pittman Act, to replace the dollars taken from her currency reserve, and which implies a bullion value for the rupee of not less than 1*s*. 6*d*. (gold). They hold therefore that if the exchange value of the rupee is fixed at 2*s*. gold (at present it would, of course, be considerably more than this in sterling) stability can be secured.

They discuss this rate more fully later on, but first make an interesting digression as to the economic effect of a high rate of exchange (paras. 44 to 50). They give reasons for holding that the rise in exchange, so far as it has checked increase of prices in India, has been to the advantage of the country. As regards the effect on Indian trade, they point out (para. 51) that while the primary result of a rise in exchange is to stimulate imports and reduce exports, these results tend to disappear—as shown by experience in connection with the 1*s*. 4*d*. rupee—when wages and other elements of production-cost have adjusted themselves to the new conditions. At present, moreover, the demand for

India's products, and the price levels in the countries which need them, mitigate the effect of high exchange, even at the outset, to the Indian producer, who also benefits by the diminished cost in rupees of the imported stores and machinery he needs. This reasoning is based on the assumption (a fairly safe one for the present) that world prices will remain high for a considerable period, and that any subsequent return to lower levels will be gradual. The Committee admit that if prices were to come down with a rush, the effect of high exchange on Indian exports might be so serious as to necessitate reconsideration of the position.

They also point out (para. 52) that the development of Indian industry is in present conditions not likely to be materially prejudiced by the stimulus that high exchange would normally give to imports, and (para. 53) that there will be a great gain to the Indian community as represented by its Government on the home charges.

The Committee then revert to the way in which stability of exchange is to be sought, a problem rendered difficult by the present divorce between the gold and sterling values of silver as of other commodities, and the concomitant depreciation of sterling currency as compared with the American dollar which rests on a gold basis. They had already, as we have seen, come to the conclusion that the rupee could be stabilised at a figure representing 2*s.* in gold, and the problem then was whether to take this as the open basis or to fix the stable figure at some corresponding amount in sterling (paras. 55–57). The latter plan would have the advantage of a less open breach with the past, and would conform to the fact that Indian exchange, for which London is the clearing-house, must in any case translate itself into sterling figures. But a stable sterling rate would be practically impossible to obtain in present circumstances, with the sterling ratio to gold constantly varying, save by its fixation at a figure which would prove undesirably high when in the future sterling and gold come together again. To adopt a fixed sterling basis would also, at present, make it impossible to establish a permanent ratio between gold and silver in India; their relations would have to fluctuate with the vagaries of gold-sterling exchange, and it would be impossible to initiate a system of automatic import and coinage of gold. The Committee, therefore, come to the conclusion that the balance of advantage lies in fixing the stable exchange value of the rupee at 2*s.* gold, which the future will also convert into a like sterling figure. I think this was the best solution they could have come to, but it means, of course, that while sterling and gold remain separate, sterling exchange quotations must be liable to constant variation. The stability is in the depths and not on the surface, and one can only hope that the position will be simplified ere long by the return of sterling and gold to their old happy union.

The practical application of these considerations is illustrated by the fact that when the Secretary of State accepted the Committee's proposal, he had to take as the then sterling equivalent of a 2*s.* (gold) rupee a sum of about 2*s.* 9*d.*, a rise of 5*d.* over the exchange rate which had been notified on December 12th last. (There has been material reduction since, with recovery of sterling values.) It is a pity in one way that the 2*s.* 4*d.* rate had not been allowed to rise higher before the new system was applied, for the sudden increase of 5*d.* per rupee temporarily disorganised trade and has been followed by a cessation of applications for the Secretary of State's councils and by a demand for "reverses" in India, the sales of which up to the beginning of March amounted to about £18,000,000 at rates which follow gold prices as led up to by the sterling-dollar exchange figures, less a deduction (taken at $\frac{3}{8}d.$) representing what would have been the expense of transmitting gold home. The Secretary of State's minimum sale prices, with reference to which he will call for tenders, will be analogously based on the cost at sterling rates of procuring gold and sending it to India. The Secretary of State has hitherto been able to meet these reverse councils out of his treasury balances, which had been swollen through repayment by His Majesty's Government of war charges due by them to India, but it has now become necessary to indent on reserves; and the first step taken will probably be to find the sterling required for payment of continued "reverses" by liquidation of some of the British Treasury Bills at present held in the paper currency reserve, a corresponding cancellation of notes being effected in India. The cessation of applications for the Secretary of State's bills has been caused by a large net demand for remittance *from* India, primarily to take advantage of hitherto undreamed of exchange rates. In time, of course, the situation will right itself, assisted, it may be hoped, by continued improvement in sterling values; and demand will once more arise, stimulated by a large surplus of Indian exports over imports, for currency in India, which will restore applications for

councils. But at the outset the new system has started in heavy waters. It will be remembered, however, that the establishment of the rupee at 1*s*. 4*d*. also took time and trouble, and the Committee gave good reasons (para. 58) against deferring action, a course which would have continued and aggravated the former uncertainties. To put the matter in a nutshell, in present circumstances a stable *sterling* exchange was impossible except at the cost of inconvertibility, or debasement of the rupee, which would be far too heavy a price to pay for it, and we must be content with having got to a stable gold point, to which sterling will also conform when normal conditions are re-established.

As regards the future adequacy of the 2*s*. gold rate, if silver should subsequently fall it would be as easy to keep the rupee above its bullion value as in the days of the 1*s*. 4*d*. standard; but it would be a much more serious matter if the price should rise to a figure which would make the rupee bullion value exceed 2*s*. (gold). The Committee advise (para. 59) that such a situation should be met *not* by a policy of inconvertibility, but by reducing the sales of councils, abstaining as far as possible from silver purchases, and promoting the use of gold. And it would be better in their view to coin rupees, if necessary, at a loss than to tamper with the 2*s*. gold standard. It seems to me, however, that these remedies could not hold good against a high and long-continued rise in silver; that would require a re-investigation of the whole position, just as past rises have broken down the old 1*s*. 4*d*. standard. But sufficient unto the day is the evil (or good) thereof, and we may hope that the new policy will at any rate have as long a spell of life as the old one. Moreover, by the time that matters may need reconsideration, India should have progressed materially in the direction of self-government, and the new policy could be considered by her legislature.

As regards future council sales, the Committee (para. 61) give complete adherence to the Chamberlain Commission's *dictum* that the primary object of the Secretary of State's council bills is not the convenience of trade but to put him in funds for his various requirements. But he may, on occasion, when this can conveniently be done and will not affect the normal location of the paper currency and gold standard reserves which is subsequently discussed, sell supplementary drafts to meet trade requirements and prevent undue accumulation of gold in India. So long, however, as present difficulties in respect of supply of silver for coinage continue, weekly sales of councils should be limited to the Secretary of State's requirements and the capacity of the Government of India to meet these. While sterling and gold remain apart, the minimum sterling rates at which the Secretary of State will offer his bills to competition must vary, being based, as above observed, on the sterling cost at any given date of obtaining gold and sending it to India; but when sterling and gold come together again the minimum rate will be uniform.

The Committee also endorse (para. 62) the Chamberlain Commission's recommendation that whenever there is a demand for these, the Government of India should, on their own motion, and without requiring sanction by the Secretary of State, sell reverse councils freely, and as has been seen they are doing this largely at present. Here, too, the sterling rates for "reverses" must at present vary according to the gold-sterling ratio.

As regards India's demand for the precious metals, the Committee (paras. 63–4) hold that previous gold imports have not been excessive having regard to the population and its needs, and that India is entitled to obtain payment for her products in the form most acceptable to her people. They trust, however, that the development of industrial enterprise and increased facilities for the investment of savings will lead to a diminution of the demands for specie. In this connection they welcome (para. 73) the coming amalgamation of the Presidency Banks, which is to be followed up by the opening of at least a hundred new branches in the next five years, and hold that the people should be more fully encouraged to make interest-bearing investments in Post Office Savings Banks and co-operative credit societies. Also that all possible facilities should be given for small investors to take part in the Government loans, to which end a post office section should be part of the normal borrowing system. That is a policy which I developed as Finance Member, and I am delighted to find the Committee endorsing it so fully.

As regards the private import of gold, this should normally be free (para. 65); but the present power of acquisition by Government should be retained till the new ratio between the rupee and the sovereign in internal circulation, which the Committee recommend, has been effected. That ratio has hitherto been fixed by law at fifteen to one; but obviously the fixing

of the exchange value of the rupee at 2*s.* (gold) requires a similar ratio within India itself, and the law should be amended accordingly (para. 69). This cannot, however, be done, as the Secretary of State has recognised, till the continued sale of gold bullion has caused the permanent disappearance of the scarcity premium of the sovereign over Rs. 15. When that position is arrived at it will be necessary to notify that sovereigns and half sovereigns, which have hitherto been unlimited legal tender at Rs. 15 and Rs. 7½ respectively, will be valued at Rs. 10 and Rs. 5, a short period being allowed for holders of existing coins to convert these into rupees at the old rates. The gold mohurs, which were issued at Rs. 15, should also be redeemed at that figure, and the mohur should then be demonetized.

As regards the use of gold in internal currency, the Committee agree (para. 66) with the Chamberlain Commission that the people of India are entitled to such currency as they prefer, but that the use of notes and rupees is preferable to that of gold. While, however, there is difficulty in meeting the full currency demands for silver, gold should be issued to safeguard the note issue, and to prevent such gold issues being looked on as a special measure indicating that the Government is in difficulties there should be regular normal issues to a moderate amount.

To buttress the gold currency it is desirable that an Indian branch of the Royal Mint, such as was established in 1918, but closed in the following year owing to difficulties in supplying the necessary staff, should be opened for coinage of sovereigns, on tender by the public of gold bullion at the rate (subject to a small seigniorage charge) of 113 grains of fine gold per sovereign, corresponding to the 2*s.* gold point in respect of the rupee; and the refining of gold for the public should, if necessary, be undertaken at the mints (para. 67). I look on this as one of the most important of the Committee's proposals. It means that while the mints must necessarily remain closed to free coinage of silver, such automatic coinage is established for gold, and will materially facilitate its import into India.

In view of the present shortage of silver, the old notification guaranteeing free exchange of rupees for sovereigns and half sovereigns, which has been in practical abeyance for some years owing to the scarcity value of gold, should be withdrawn, though the Government will naturally continue to exchange one form of coin for another when it can conveniently do this (para. 68).

The Committee recommend (para. 70) that the present restriction on the import of silver should be done away with; otherwise, when the bullion value of the rupee is close on its exchange value, the silver required for non-monetary purposes is likely, in spite of any legal prohibition, to be obtained by melting, thus increasing the necessity for fresh silver purchases by the Secretary of State. As a corollary to this they propose (para. 71) that a special import duty of 4 annas per oz. on silver, introduced for fiscal reasons in 1910, should be withdrawn, as it hampers imports, and provokes melting when the bullion value of the rupee is near its exchange value. Both these proposals have already been carried out, and the prohibition of the melting of coin has been withdrawn.

Restrictions on the export of silver must be maintained so long as the bullion and exchange values of the rupee are close together (para. 72).

The present arrangements under which the Secretary of State purchases silver for coinage should continue (para. 74).

The Committee next discuss future policy in regard to the paper currency reserve. As we have seen, the necessities of the war period brought about a very large increase in the invested portion, which was gradually raised by a series of temporary enactments that will presently expire from 14 crores (ten in Indian securities and four in British) to a maximum of 120 (twenty Indian and one hundred British); but this last limit has not been fully worked up to. At the end of March, 1919, against a gross circulation of about 153½ crores, the metallic holding was nearly 55 crores, or below 36 per cent., and the investments totalled about 98½ crores. At the end of November the position was better; the gross circulation was nearly 180 crores, against which about 80 crores or over 44½ per cent. were held in metal, 17 crores in Indian securities and 82½ in British. At the end of February it was somewhat better still; against a gross circulation of 183 crores, 85 crores, or nearly 46½ per cent., were held in metal, about 15½ crores in Indian securities, and 82½ as before in British; the latter holding being almost entirely in Treasury Bills. The Committee note with approval (para. 75) the large expansion of the note issue, but justly observe that its popularity can only continue so long as its convertibility is placed beyond possible doubt. They agree with the Chamberlain Commission (paras. 77–79) that the old system of limiting the

fiduciary portion of the paper currency reserve to a rigidly fixed amount is undesirable, and should be superseded by a percentage ratio on the circulation, which they propose to fix by laying down that the metallic portion shall amount to at least 40 per cent. of the total note circulation, leaving a maximum of 60 per cent. available for investment. They admit, however, otherwise their proposal would be rash in view of recent difficulties, that the statutory minimum for the metallic portion should in practice be materially exceeded, especially at the commencement of each busy season. Of the fiduciary portion they recommend that up to 20 crores should be tenable in Indian securities, and the balance in those of Great Britain and of other Governments within the Empire, while of this latter amount all but 10 crores should be in securities of not more than one year's maturity. On the figures given by the Committee for November 1919 this would have involved a maximum holding at that time of 20 crores of Indian and nearly 88 crores of British and Imperial securities. They recommend, however, that in view of the present difficulties power should be taken, in the legislation that will be required, to retain for a limited period the total permissible maximum of 120 crores for investment given by the temporary enactment above referred to. Personally, I should like to see the metallic holding of the paper currency reserve fixed normally, at any rate for a considerable period, at not less than 50 per cent. of the note circulation.

The Committee also recommend (para. 80) that a further special issue of notes up to 5 crores, to meet seasonal demands for additional currency, should be made on the security of short-term commercial bills of exchange endorsed by the Presidency Banks (hereafter the Central Bank of India), these notes being issued as an advance to the banks, carrying interest at not less than 8 per cent.

The note circulation being in rupees, the composition of the paper currency reserve is rightly described in terms of rupees also, and for this purpose its gold holdings and sterling investments have hitherto been taken at 15 rupees to the pound. The change in the gold value of the rupee will necessitate (leaving out of account the temporary depreciation of sterling as compared with gold) the revaluation of these at Rs. 10 to the pound, involving on present figures a deficiency of about 38 crores to be made good to the paper currency reserve. It is recognised that this large deficiency, which in time will be more than covered by savings in home charges brought about by the increased value of the rupee, cannot be made good at once, but it is proposed that this should be done gradually against the savings obtained under home charges (para. 79).

The location of the paper currency reserve should normally be in India; but, as hitherto, silver under purchase or in course of shipment should be treated as part of the reserve, and some of the gold may be held in London, either as awaiting subsequent shipment to India or as being presently required for silver purchase (para. 81).

As soon as circumstances permit, the old facilities for the encashment of notes outside currency centres should be restored, though these should continue to be a matter of grace and not of right (para. 82). The temporary restrictions, previously referred to, on the transit of silver from these centres are obviously intended by the Committee to be withdrawn as soon as possible.

As regards the gold standard reserve, the Committee (para. 83) endorse the Chamberlain Commission's view that in present circumstances it should continue to receive the whole of the profits on coinage. They review (para. 84) the composition of the reserve at the time they reported, which then amounted to about £37,500,000, practically the whole of which was invested—mainly in British Treasury Bills and Exchequer Bonds maturing in 1920 and 1921, and in National War Bonds redeemable in 1922. They refer to the Chamberlain Commission's proposal that half the total reserve should be kept in actual gold, and admit in principle that there should be a considerable proportion of gold holding; but they think that in present circumstances such gold as can be obtained for the Government of India should be preferably held in the paper currency reserve, and that it will suffice to lay down that the gold standard reserve investments should be in British and Imperial securities, having a maturity of not more than twelve months. In my humble opinion this decision is not altogether satisfactory, having regard to the fact that, under the Committee's proposals, the metallic portion of the paper currency reserve (gold plus silver) may run down to only 40 per cent. of the note circulation; and I think it is desirable, for the purpose of stimulating public confidence, that a material portion of the gold standard reserve should be in gold. The Committee recognise the value of this confidence asset when they go

on to suggest (para. 85) that a portion, not exceeding one half, of the gold held in the reserve should be located in India and set apart for export purposes; but the suggestion seems to lack practical value, in view of the Committee's finding in their previous paragraph. I may explain, however, that final orders have yet to be passed on the proposals relating to the paper currency and gold standard reserves, and on certain cognate matters.

I am sorry to have to close my analysis of the Committee's proposals on a note of difference, but this does not in the least detract from the admiration I feel for the report as a whole. And it is a matter for peculiar satisfaction that though the Committee's members must have approached the grave problems with which they had to deal from diverse standpoints, they came to almost complete unanimity on the many important issues before them. The only dissent, indeed, is a minority report by my genial friend, Mr. Dadiba Merwanjee Dalal, of Bombay, in which he proposes to keep the old ratio of 1*s.* 4*d.* per rupee, both for exchange and internal circulation purposes, and to effect this by giving full freedom for the melting and export of rupees and the import of gold. He proposes to meet high silver prices by abstaining from the issue of rupees of the existing pattern so long as the American price per silver ounce is above 92 cents, and to fill the gap by the issue of a 2-rupee coin of reduced fineness and a similarly reduced 8-anna silver piece. He also recommends that reverse councils should be sold at 1*s.* $3\frac{29}{32}$*d.* It is difficult to take this scheme seriously, as it is absolutely open to the Secretary of State's criticisms that it would involve depreciation of the coinage, drain on silver stocks which must entail grave risk of inconvertibility, a demand for gold which would impose a heavy strain on the world's stock, an immediate crash in exchange through the operation of the reverse councils proposals, and inflation of prices.

And now I shall relieve you by bringing my remarks to a close. I fear I have trespassed over much on your attention, but I have found it impossible to bring into shorter compass the developments and vicissitudes of a long period, and the grave strain which unforeseen happenings during a prolonged world-war brought on India's currency system. Fate may yet have other and great vicissitudes in store for us, but I think we may regard the success with which past difficulties have been met as a satisfactory omen for the future.

DISCUSSION.

THE CHAIRMAN (Lord Chalmers) said he thought no one could have traversed so much ground so ably, and yet so succinctly, as Sir William Meyer had done. He had expressed a fear, towards the close of his paper, that he had trespassed overmuch on their time, but he could assure him that that was not the case. It had been a great relief to him (the Chairman) to find that the paper was not a polemical one; it was enough to be in the chair without being in the dock as well. From 1913 to 1918, as Finance Member of the Governor-General's Council, Sir William Meyer had had to deal with a situation fraught with difficulties, the quality and quantity of which were unparalleled, and that applied also to all those who were responsible for finance in other parts of the world. Finance was always the handmaiden of government, but in times of crisis and panic it becomes its scapegoat as well, and there were many astute people who found in finance a ready means of carrying on an offensive defence of their own shortcomings. He ventured to prophesy that when people came to look back on the unparalleled period through which they had passed during the war, the verdict of economic history would be a kindly one; and those who, like their lecturer that afternoon, had borne the burden and the heat of the day, would find in that verdict a generous, if tardy, meed of praise. Sir William Meyer's last words were: "Fate may yet have other and great vicissitudes in store for us, but I think we may regard the success with which past difficulties have been met as a satisfactory omen for the future." That applied not only to Sir William, but also to the four Currency Commissions which had reported from 1893 to 1919, with all of which he (the Chairman) had had the privilege of being associated. Those four Commissions had at least one thing in common—they were actuated by the desire to regard the very difficult problems submitted to them in the light of the interests of the people of India. From his acquaintance with those Commissions he would say of those who sat on them, in the words of Sir Henry Fowler, "They were all members for India." The last Commission, over which Sir Henry Babington Smith presided, had not been backward in following that ideal. That Commission had been at one with Sir William Meyer in declining to listen to any counsels of despair, and in not giving the faintest countenance to any steps which led towards inconvertibility. It was with the greatest reluctance that they had departed from the principle of linking the rupee to sterling. However, they had departed from it, and in his judgment rightly. They had advocated as the basis of Indian currency not the sterling pound—the "Bradbury"—but the golden sovereign, and they had arrived at that conclusion—which was not an easy or agreeable one—solely in the interests of India as a whole, and feeling that that was the policy along which India's interests would lie in the future. They had been deeply influenced by the fact that in advocating

a gold basis for the currency of India they were doing their best to safeguard the interests of the helpless masses in that country.

LORD BALFOUR OF BURLEIGH, K.T., P.C., G.C.M.G., G.C.V.O., said he had been much interested in Sir William Meyer's paper, having to a certain extent tried to study the problems with which it dealt. He represented the Cabinet on the 1899 Commission, and was glad to think that the foundations then laid had been justified by the course of events from that year until the outbreak of the war. The change brought about by the war was very extraordinary. In 1899 the problem was how to keep the rupee up to 1*s.* 4*d.*; the problem now was how to keep it below 2*s.* 8*d.*, rather a change of circumstances. He thought they all owed a great debt to Sir William Meyer for his interesting and exhaustive survey of the history and development of Indian currency. The paper proved that, whatever might be said by some people, the policy of the Government of Great Britain towards the people of India had been guided by honesty and straightforwardness. They had tried, and he thought successfully, to maintain the confidence of the people of India. He cordially endorsed the principle that in the future, as in the past, they must take care that the convertibility of the note issue in India should be beyond doubt or suspicion. He had been glad to hear of the prosperity of India's trade, which he thought was attributable to the way in which they had supported the exchange in that country. For the trouble they had taken in that direction they had, he thought, reaped their reward by the noble way in which their Indian fellow-members of the Empire had stood by them recently in the cause for which they had been fighting. The loyalty of the people of India, differing as they did in race, religion and circumstances, had deeply impressed this country with the value of justice and fairness. He was glad to be present to give his humble testimony as to the way in which many who had no personal interest in the matter were yet deeply concerned with the welfare of their Indian brothers.

MR. MORETON FREWEN said he was glad to join with Lord Balfour of Burleigh in his appreciation of Sir William Meyer's paper. He regarded it as a classic on the subject, and as likely to be of great historical value. He was one of those who viewed the whole experiment of a gold standard for India with the utmost dismay, and he thought the great majority of thinkers were coming round to that opinion. He had just crossed from San Francisco to New York. Although the conditions in America pointed to a most remarkable prosperity, the appalling dangers of the European situation connected with sterling exchange had almost dried up the fount of charity. Since the commencement of the fatal experiment of 1893 this country had lost to India over three hundred millions sterling of gold. If they had that gold here to-day in order to assist reconstruction, the problem would be enormously simplified. If the immense series of experiments, to which every fresh Treasury hand who went to India added something new, was to be continued, it was certain that as exchange conditions became more normal they would lose to India at least forty million sovereigns a year. The three hundred million people in India had been, according to the admission of every Finance Member, perfectly satisfied with silver, and the idea of giving to them the gold which was needed so urgently in this country was altogether wrong. There was not enough gold for the purpose, and in attempting to carry out that policy Great Britain had lost her own gold standard permanently. What chance had we or France or Italy of resuming specie payments if this hæmorrhage continued to Asia? For hundreds of years the East, with its eight hundred millions of people, had had favourable trade balances against the West, and they had always drawn those balances three-quarters in silver and one-quarter in gold. The hundred per cent. rise in gold prices in the last six years meant that where India drew one ounce of gold before, she would now draw two, and the same with silver, so that favourable trade balances would require twice as much specie as before to liquidate them. There was no gold to do it with. The currency had been so tinkered with that there was no longer even sufficient silver to pay the trade balances owing to Asia. He had studied the question in India and outside for thirty-five years, and he had no hesitation in saying that the old honest currency system of India—the freely-minted silver rupee—which had been destroyed, was a most admirable system. Before 1893 the rupee was melted down, and the currency was thereby automatically contracted and a rise of prices guarded against. As Goschen said at the time, no matter what happened prices in India remained stable. That splendid condition of price stability had been destroyed in order to give India a currency system she disliked, and which must involve the ruin of our finance. Several references had been made in the paper to the assurance of the Chamberlain Commission that India should have the kind of currency she preferred, no matter what its cost to the outer world. Did anyone believe that three hundred millions of poor ignorant people in India were clamouring for a "gold standard"? They had always desired to get silver, and had never taken gold except to hoard it, nor ever would. At the time of MacKinley's election as President a conference of representatives of Great Britain, France, and the United States was held at the Foreign Office, and the Americans offered, together with France, to open their mints to the free coinage of silver, the Indian mints to re-open. All that this country had done was to refer the matter to the then Viceroy of India, Lord Elgin, who, knowing nothing about currency

questions, was permitted to negative this splendid offer. If the Republican Party got into power in America—and he thought they would—they were likely to make a proposal to the European Governments that they should open free mints for silver, and thus stabilise the exchanges. The currency system brought into use by the Fowler Commission was merely the miserable old "Bland Act" repealed in the United States in 1893. Before any settlement could be made in the Indian exchange problem the bad work done since the date of that Commission would have to be reversed. To illustrate the importance of allowing free coinage to the natives who had got hoards of silver, he said that at Allahabad during the famine of 1897, the headman of two villages situated in the worst part of the famine district came in with two thousand tolas of silver bullion and ornaments in order to buy food for the villagers. He ought to have got, and would have got had the mints been open, two thousand rupees for this silver; but the best price he could get was six hundred rupees from a local shroff. By how much was the death-rate added to?

Mr. George Miller (Chartered Bank of India, Australia, and China) said that he was in Bombay at the outbreak of the war, and could thus bear witness to the strenuous times Sir William had to go through. He had had many difficult problems to face, and many anxious moments during the whole period of his office. It was stated in the paper that reverse councils had been so largely applied for in India that they constituted a drain on the reserves. Was there any necessity for offering reverse councils at all? So far as he knew, they seemed to be largely availed of by speculators. The rates at which the Government had been obliged to sell were in many cases *3d.* to *4d.* above the current market quotations.

Mr. G. Findlay Shirras, M.A. (Director of Statistics with the Government of India), speaking for himself and for the other visitors, said they had been much interested in Sir William Meyer's admirable paper. The linking of the rupee to gold was a very great boon, and it was thoroughly appreciated by those who had watched the development of Indian currency during the last few years. He entirely agreed with the Chairman that everything that had been done by the various Currency Commissions had been done with a single eye to Indian interests. At the present time the gold sovereign was at a premium of 29 per cent. as compared with the paper pound, and the policy of linking the rupee to gold instead of to the pound sterling had many advantages, which were referred to in the Report of Sir Henry Babington Smith's Commission. India had a favourable balance of trade, and it was therefore a very great advantage for her currency to be linked to gold. In regard to that and to the fixing of a high exchange, it must be remembered that the question of preventing a high rise in prices in India was very important indeed, although unfortunately it was not realised by everybody. With regard to what Mr. Moreton Frewen had said, he thought he was speaking from the Indian standpoint when he said they totally disagreed with him. India was entitled, as the Commission had said, to a share in the world's metals, and was entitled to take what she required in the form in which she required it. It was a great satisfaction to them to find that the Indian Mint, a branch of the Royal Mint, was to be opened, because at the present time in India sentiment counted for a very great deal, and the opening of that mint appealed to their national pride. The Commission had also approved of the sale of gold in India, and it was a matter for consideration whether the sales could not be made through the banks and their branches, and perhaps through selected treasuries, in amounts of 20 to 25 tolas in order to get at the middle-classes, who had to buy gold for marriage and other quasi-religious purposes. Next in regard to the question of inconvertibility, to which Sir William had referred, the Government of India at that time—he spoke as an outsider, not being in the department affected—only regarded the question as one of passing expediency which would not last for any length of time. Luckily it was avoided, and he thought they all agreed that in a country like India it had to be avoided if it was possible to do so; but at that time there seemed to be no other way out of the difficulty. It was only to be temporary and only to be introduced as a last result. As he had pointed out in his recent book, "Indian Finance and Banking," he was not in favour of the proposal, but he thought that Sir William Meyer had not quite put the viewpoint of the Government of India altogether fairly. He could speak of Sir William Meyer's work in India from a detached point of view, as he had not had the pleasure of his personal friendship; but he had long felt that Sir William was a good man to go tiger-hunting with. He had started his career nearly forty years ago, when he (the speaker) was in what was popularly known as the nursery; he had given his whole services to the interests of India, and in spite of domestic afflictions had held on to his post during the war, when they had felt in India that the existence of the Empire was at stake and it was their duty to rally to its defence. They realised how much Sir William had done for India; that he had done far more than was generally recognised. He could tell some stories—but he dared not do so—of the work Sir William had done, of how he had fought India's battles and safeguarded her expenditure. They appreciated to the full all that Sir William had done, and hoped that he would look back on the trials through which he had passed with pride and with the greatest possible satisfaction.

Mr. Gershom Stewart, M.P., said that although he did not entirely agree with all Sir William

Meyer had said, he had listened to the paper with profound interest. He sympathised, to a certain extent, with his old friend, Mr. Moreton Frewen, and regretted that India had taken gold so closely to her bosom. The Chairman had stated that he had been associated with four commissions enquiring into Indian currency. It had occurred to him, when he heard that remark, that the constitution of the Indian currency system must be a little rickety, if four commissions were required within twenty-seven years to consider it. He was in China when the Indian mints were closed to silver, and he would have much preferred leaving those eight hundred millions of people—three or four hundred millions in India, and about the same number in China—to go on with the one metal which had sufficed them for centuries. The boycott of silver brought about a panic amongst salaried officials. Men saw their salaries, when paid in rupees, decreasing in value, but he thought it would have been better if they had been given an exchange allowance, and their minds relieved in that way. At the time when the Indian mints were closed he happened to be in New York, and he had asked the manager of the Hong Kong Bank at New York what was the price of silver. He replied: "It has got no price." He thought that answer was rather "up against" the action that India had taken against silver. He had been engaged in what he might term a lone fight in the House of Commons for the past fortnight, protesting against the depreciation of the coinage of this country and of the African Colonies. One thing in the report of the recent Currency Commission which appealed to him more than any other was that they had had the wisdom to say they would not debase the rupee in India, and that they would not haul down the flag because of temporary trouble in the silver market. Since that Commission had reported, the price of silver had gone down considerably. The Government were to be congratulated in maintaining the rupee as a pure coin, and he hoped the same principle would be maintained throughout the Empire; honest money was the best.

Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I. (Chairman of the Indian Section Committee), said he desired to convey to Lord Chalmers the cordial thanks of the Royal Society of Arts for his kindness in coming to preside at the meeting. He also wished to propose an equally hearty vote of thanks to Sir William Meyer for the extremely interesting and able paper which he had read.

Mr. J. A. Toomey (National Bank of India) said it afforded him much pleasure to second the resolution. Sir William Meyer had given them a most interesting paper, as was to be expected from such a high authority. The business world, to which he (the speaker) belonged, had the highest regard for the courage and ability Sir William had displayed throughout his term of office in India.

The vote of thanks was carried unanimously.

Sir William Meyer, in reply, thanked the Chairman and those who had taken part in the discussion for their kind remarks. There were not many criticisms for him to meet. His friend Mr. Moreton Frewen still remained of the opinion that, in the classic words of Mr. Bryan, India "should not be crucified on a cross of gold." He did not wish to enter into a discussion on that, because the change was made nearly thirty years ago. Events had moved rapidly since that time, and even if they wished to do so he did not think they could restore the old order of things. He would remind Mr. Frewen that four impartial Committees had maintained that the closing of the mints was a sound and necessary step, and secondly that gold came into India even when the mints were free. The finances of the Government of India were so embarrassed by the fall in the value of the rupee in 1893 that if some measures had not been taken to deal with it extra taxation would have been necessary. Mr. George Miller had asked why the Government should go on selling reverse councils on more favourable terms than the banks could offer. So long as there was an exchange in which the Government had to intervene, the Government had to do its best to keep it up. If a crisis occurred in the exchange, the very fact that the Government showed its support by selling reverse councils tended to establish stability, which was the prime object they had in view in instituting reverse councils. It was rather like what he had noticed as a humble private individual since he had come back to England; when the British Government took certain steps under D.O.R.A. at once people said that prices were going up because of Government control, and urged that that control should be removed. As soon as the Government did this prices went up still higher, and then people immediately said, "Why on earth did you relax your control?"

The meeting then terminated.

SIXTEENTH ORDINARY MEETING.

Wednesday, April 14th; Sir Herbert Morgan, K.B.E., in the chair.

The paper read was—

THE FUNDAMENTAL BASIS OF GOOD PRINTING.

By Joseph Thorp,

Member of Council, Design and Industries Association.

Good printing—what do I mean here by "good"? The word might have been chosen deliberately to focus attention on the mechanical side of printing and refer to merely technical efficiency—good inking and even impression; whereas I wish to refer more particularly to

the design of printing, what might be called the æsthetic or "artistic" side. But that last word at least has been too often profaned for me to profane it further.

My main thesis is that in printing, as in all the practical or applied arts, the æsthetic and practical aspects cannot be separated. "Fitness-for-purpose" is the test. Here is to be found the fundamental basis. Made things are not artistic if they don't "do their job," if the ornamentation is something added or stuck on, not flowing out of the nature of the material and the practical purpose of the plan. This is the thesis of the Design and Industries Association; it was admirably stated (and occasionally in practice denied) by William Morris; it has been brilliantly re-stated by Professor Lethaby (*e.g.* "A work of art is a well-made thing, that is all." "Art is not a special sauce applied to ordinary cooking. It's the cooking itself if it is good"—words which I should like to see engraved on the portals of every Art and Craft school in the country).

The Forth Bridge, depending for its appearance on the due balance of thrusts and tensions in the material chosen (steel), is a truer and therefore more beautiful thing than the Tower Bridge, which was consciously "decorated" to make it "artistic." The modern motor-car, as developed from the first clumsy horseless broughams along the lines of the engineering solution of its practical problems—speed, wind-resistance, stability, etc.—is certainly a more beautiful thing than it would have been if Professor Herkomer's appalling suggestion of fitting those same mechanical broughams with prows in shape of swans had been followed. Battleships, aeroplanes, weapons, tools, implements of sport—these develop their own form of beauty (or, not to claim too much, avoid falseness which is ugliness) by sticking to the lines of fitness-for-purpose. Architecture and furniture-making likewise. I am afraid tailoring and dressmaking follow another rule, dictated by vanities and interests rather than principles, or women would never have worn crinolines or hobbles, and certainly men would never have encased themselves in the Victorian (and so far as one can see) Eternal *Cul(otte)-de-Sac* of Trousers.

Good printing, then, is primarily printing that does its job. Legibility is its first requirement. Persuasiveness one might state as its second—to include comeliness and appropriateness. That is to say, a printed thing must first be able to be read. And read easily, pleasantly; therefore we add the "persuasiveness" of comely, appropriate design. Tradesmen selling goods by advertisements have realised this truth. But if you consider the matter, nearly all printing is advertisement in the sense that it announces something which the announcer wants read. Refusal to understand this abject platitude accounts for much squalid and careless printing. If I am told that good printing is expensive, the general lines of my answer are: first, that bad printing that isn't read is dear and wasteful at any price; second, that a good deal of what goes to make good printing is not a question of cost at all, but of knowledge and care.

Legibility, then, is our first desideratum. We must begin with a legible *letter*. We want to find the most legible type of letter within the limits of the forms of the traditional alphabet—in our case the Roman capitals and small letters with their Italic. And here we must distinguish between the *absolutely* most legible and the *practically* most legible. It is obvious that if we were designing an ideal alphabet to-day—an absurd supposition anyway, as all practical arts are gradual evolutions in which tradition plays a greater part than originality—we should avoid such similarities as are involved in these groups: CGOQD; PRB; EFB; eco; il; mnu; bh. There are too many coincident parts of these letters to ensure perfect legibility. But the alphabet as we have it is an established code. The difficulties of introducing an ideal letter are now insuperable—though we have got rid of the long s—ſ. We have to keep the essential forms as we now have them; and we don't want "original" or "fancy" letters to interfere with the rapid-signalling of the sound which is the function of a letter. A triumphantly beautiful form of Roman capital survives in the incised inscriptions of the Trajan column. As to the smaller or lowercase letters, the art of printing came happily at a time when the art of writing was at a noble, not a debased, period, and the early printers had the most superb models both for their letters and for the arrangement of their books. One notes in passing how the new art leant on the old in the first period of its development.

It is extremely comforting to those of us who prefer the old-style and old-face letter, with its freer drawing, its broader forms, and, as we judge, better distribution of thick and thin, to the "modern" face with its fine hair lines, its too starkly contrasted thicks and thins, its tendency to compression, its mechanical pre-

cision, to know that the old style and old face is demonstrably by laboratory tests the more legible. A notable gain in legibility readily appreciable by even the uninstructed eye is in the old-face figures with their ascenders and descenders 123456789 as contrasted with 123456789, where particularly the 3 and 8, and often the 3, 8, and 9, are easily misread, especially in small sizes, or if at all battered or weak in impression.

Having chosen a legible letter we must then aim at a legible combination of letters. The design of a printed page is in simplest essence the arranging of a panel of black (or, in fact, grey) on a white (or light) paper. The white spaces left—margins, etc.—are an essential factor of legibility, as they are an essential part of the design. Margins equal and sufficient (that is sufficient to rest the eye) all round would serve our fitness-for-purpose test, but to achieve comeliness, we, if we are wise, so arrange our panel that our tail (foot or bottom) margin is appreciably greater than the others. If we are designing a book we assume the double opening of two pages to be the unit of design and arrange our double page so that the head margin is smaller than the middle (or gutter) and two foredge (side) margins (these three are equal); the tail margin we make largest of all. Let us accept this standard from the finest practice and then seek practical reasons for it. First, if a panel be so put on the page that head and tail margins are equal, it does, in fact, by an optical illusion, look as if the tail margin were smaller. Secondly, the book is held by the thumbs, by the tail margin. We need, then, thumb-room. There is probably also some demand of the eye derived from a common principle in architecture that the building needs a sufficient "base" to look (and generally to be) right.

Amplitude of margins is a matter for individual decision, depending on size and weight of type, limitations, etc. The ample wide margins of the earlier printed books were possibly designed to admit of annotations by the reader according to the practice of the period. If so, they might reasonably be reduced in modern days. One has seen books published in two editions, ordinary and *de luxe*, where "*de luxe*" merely means that the edition has over-ample margins surrounding the same sized panel of type. This is not "art" but folly or pretentiousness—a small oasis of dwarfed type in a waste of white paper.

A very important point to determine is the length of line in proportion to the size of type. It must not be so long that the eye needs a deliberate effort to pick up the beginning of each line, an effort which is increased as the size of type decreases. It has also to be remembered that the plane of a page being flat the eye is theoretically in perfect focus (if the reader keeps his head steady) only at one point of the line (say the centre), and is at all other points of the line out of focus to a greater or less degree according as the line is longer or shorter. I consider 4½ in. to be quite long enough for 14 point type; 4⅜ for 12 point; 3⅞ for 11 point; 3⅛ for 10 point; 2½ for 8 point. These measurements are approximate, empirical, and perhaps a little arbitrary. It is a very common thing to see these measurements almost doubled. I am a strong advocate, on both æsthetic and practical (including economical) grounds, of the revival of the double-column page. Cost of paper is inducing publishers to use smaller type without cutting the size of the customary page. This means "bad" printing.

The use of ornament needs careful restraint. When in doubt omit. When not in doubt try to get in doubt. As a first step to right use of ornament cultivate an ascetic severity. Some printers can never resist filling up odd spaces of white with bits of "ornament," rules, etc. Advertisers have long been driven by competition to recognise the value of white space for emphasis, of simplicity as against complexity. This teaching is perhaps negative rather than constructive, designed rather to avoid ugliness than to create positive beauty. Yet orderliness, due proportion, fitness for purpose, right use of material, avoidance of fakements—all this means positive beauty in the practical arts.

DISCUSSION.

THE CHAIRMAN (Sir Herbert Morgan, K.B.E.), in opening the discussion, said he was sure everyone present appreciated the author's eloquence and activity. If the world were filled with the kind of printing that the author had so much at heart he thought it would be a far finer place, but it was necessary to consider how far it was possible for the author to realise his ideals. He had said that he "put over" the fact that good printing meant fitness for purpose, and personally he thought the author might congratulate himself on the fact that he did "put it over." It was in his opinion an extremely able definition of good printing, but he would like to ask the author who was to judge as to the purpose, and whether he

would give a little more illumination on the subject of the purpose. Broadly speaking, printing was produced either to be sold—in which case he took it the purpose was to sell as much of it as possible—or to convey knowledge and information. With regard to the printing that was produced to be sold, probably those responsible for its production would say—by taking certain perhaps grave liberties with the ideals set forth by the author—that that book would be the most successful which would "take on" with the public, and in that way it would achieve fitness for purpose. With regard to printing used to convey knowledge and information, so many people wanted their own information conveyed and their own knowledge spread that a strong competition of method was the result. He was afraid that the author's ideals were a little too severe and restricted to find favour with those people who produced books in order to sell them, and in the same way those who were competing for the education of the people found it necessary deliberately to depart from the rules and regulations that the author had drawn up. Was it possible that they could achieve their fitness for purpose and at the same time produce the good printing which the author had so much at heart? One other thought had occurred to him in connection with the paper, namely, that in considering fitness for purpose in printing he felt much more might be done to link up good printing with the architecture of our streets and buildings. The capacity of all good printed notices or even the humble lettered sign in the shop window to illuminate a dull and drab thoroughfare and to elevate public taste was, in his opinion, very great indeed, but in that respect also he felt one would have to take certain liberties with the author's very strict views.

Mr. J. R. Riddell (Principal, St. Bride's Institute) said the paper had been illuminating and interesting, and at the same time humorous, but personally he thought it would have been better if the author had spent the first twenty minutes of his time in giving his own views on good printing rather than in dilating on the inartistic forms of rustic arches, motor cars, hammers, trousers, crinolines, etc. Like the Chairman, he would very much like to hear what the author had to say about fitness for purpose. In dealing with type faces, the author was on safe ground when he stated that the first principle of a good letter was its legibility, but who was to determine which was the best letter? Everyone had different views as to the form that the ideal letter should take, and therefore it was not advisable for any person, or groups of persons, to set up as a standard a particular form of letter and say that that was the only correct form for the letter to take. The author certainly made a happy hit by the phrase "fitness for purpose," but again, who was to determine the correct interpretation of the fitness for purpose of a particular style or letter in a piece of printing? No self-respecting printer would set up a milliner's advertisement in the same type that he would use for an undertaker's announcement, but within those two extremes there was a wide field for individual expression by the use of type. It had to be recognised that, no matter what one's personal ideals might be, or how much some printers would like to see a simple style of printing, it was the man who paid the bill who called the tune, and really it was the customer who needed educating to the fitness for purpose. A great deal could be done by enthusiastic printer-craftsmen and persuasive printers' salesmen in educating the buyer of printing, and thereby helping to place the art on a sound foundation; but, after all, printing was a commercial proposition, and the customer demanded, and usually obtained from his printer, the style that he considered best suited to his particular needs. The author referred to the work of William Morris, and gently hinted that it left something to be desired. Personally, although he took second place to none in his admiration for some of the works of Morris, he did not hesitate to go further than the author and to say that it would be well for Morrisian disciples to recognise that their master issued some of the greatest abominations ever put forth from the printing press. Some time ago he was responsible for printing a booklet in the Morris style, on hand-made paper. He submitted the work to a Morris enthusiast, who considered it to be a fine example of printing, and expressed a wish to obtain a copy, but when it was made known to him that it had been mechanically composed and printed on a modern high-speed printing machine his keenness to obtain a copy of the work was not so apparent. That attitude, he thought, was not helpful, and it was unfair that any society or educational body should set up a certain style of work and say that that was the style which must be followed, often to the exclusion of all others. The author had referred to proportions and margins, and had shown an example of a panel of lettering placed geometrically in the centre of the page for the purpose of disproving the contention that it was necessary to raise the printed matter on a sheet a little higher than the centre so that it might have the appearance of being centred. If the author had taken a single line of type instead of a panel some two inches deep, he thought the optical delusion would have held good. It had been correctly stated that the large margins, which had been adopted from the written book, allowed for the handling of the book. He suggested that they also served another very useful purpose, in that, if the book had to be re-bound and trimmed at some future time—and most bindings gave out before the print—large margins enabled that to be done with less chance of losing the pleasing proportions of a well-printed page. With regard to the diagrams drawn by the author and his reference to printers looking upon type as "lumps of metal," he would like to remind him of a point that he,

along with numerous advertising experts, frequently lost sight of, namely, that many types had what was called a "beard," *i.e.* a blank space left on the body which must be allowed for when "laying-out." The author must certainly be complimented on his witty discourse, which, personally, he had very much enjoyed, but he was afraid the author had not thrown much light on what was "the fundamental basis of good printing." The most sincere compliment that could be paid to him was that he would undoubtedly make a better salesman than printer.

MISS A. DEANE BUTCHER said that the organisation with which she was connected wished to send half a million books and a thousand commercial travellers to Russia, and the ordinary letter "H," which consisted of two perpendicular lines with a horizontal line between them, was read by the Russians as "N." That was due to the fact that the Russian printer had degraded the type, because in the old religious literature of Russia one found that the "N" was made very nearly the same as the English "N," the only difference being that the oblique line did not come quite to the top of the letter. It was clear that it was natural to man to degrade type. The hand-made type had been gradually degraded in a way that Mr. De Vinne, who was the American authority on the subject, described as feminine. He said that all the printing that was bad, all the printing with which he disagreed, was feminine, and that all the printing which was correct was masculine. The author had said that regard must be had to fitness for purpose, and in sending books to Russia one surely ought not to print the letter "H" in such a way that it would mislead the Russians into thinking that it represented the sound "N." The same observation applied to the writing, or lower case, letters "n" and "m." The Russians pronounced the writing "n" as we do the letter "p," and the writing "m" as we do the letter "t." Common sense demanded that these lower-case letters "n" and "m" should be omitted and the small capitals "M" and "N" substituted. These were equally legible to English and Russian people. With regard to the traditional "N," the lower case "m," much difficulty had been experienced. It should not be put into a typewriter. Mechanical printing was necessary now because there were so many people in the world, and neither time nor money could be afforded to do the beautiful work which could be done by hand. But when one was dealing with an educational print, such a print as was necessary for a foreigner or for a child, surely it ought to be done for the people that were going to read it. If one was going to write for Russians one must make letters that did not mislead the Russians. All the Russian letters could be transliterated into English letters, and *vice versâ*, although in England there were now three or four different transliterations, each one of which was very confusing. A well-known Russian scholar said that could not be done, but by that he only meant that he personally could not do it. The Roman type was regarded by some people as though it came down from Heaven with the Ten Commandments, but it must be remembered that that type was made originally for the Latin language, and the English were not Latins and did not speak the Latin language, although they had a great number of Latin words. Sir Arthur Shipley, the Vice-Chancellor of Cambridge University, said in his testimonial to orthotype printing that it was very excellent, because in a very short time the word of an Englishman would not be understood in Canada nor the word of a Canadian in England, but when he was sent some specimens to give to his foreign friends he said the print was very ugly—that was to say, it was not familiar to him and therefore it was ugly. Professor Adamson, of King's College, in his book on "The Practice of Education," said: "The teaching of English reading is not an educative process." That meant that large sums of money were being spent upon teaching people by a process that was not an educative one. That was because the books were not written in an educative manner. She would like to hear from the author what the small modifications were that he would allow to be made in the Roman type. There was a method of making very small modifications in the English language so as to produce an educational print, and that was by adding to it interlinearly seven shorthand letters. When in Canada she had had some trouble by asking for "Bāliol Avenue," when the street was known locally as "Balĭol Avenue," and that was one example that showed the necessity of producing an educational print which would serve as a key to the ordinary print and would show where the emphasis in a word came.

MR. LEON GASTER agreed with the author that it was very useful to print in two columns, as it was much more convenient for the eye to travel a short distance (not exceeding about four to six inches). It was very important to study the nature of the paper on which one was printing. When a magazine with which he was connected was started he had great difficulty in obtaining a paper with a matt surface sufficiently free from gloss and yet revealing half-tone blocks satisfactorily. The difficulty had, however, been so satisfactorily overcome that in a Report of the Committee of the British Association on Schoolbooks and Eyesight, issued in 1915, that journal was placed first on the list as complying best with the required absence of glossiness. The size of the type was an aspect of the subject in which he was very much interested. He wished that printers would raise their voice against a very small print. In some of the magazines intended for children the paper, the printing and the type were such as ought not to be passed. The Bible was often produced in a type that it was extremely trying for a child to have to

read, even by a good illumination; if an opportunity presented itself to have the Bible re-cast several editions should be made with a more readable type.

The Author, in replying to the discussion, said that the difficulty with regard to a standard type to deal with the question of pronunciation was that climatic conditions would always make different pronunciations. The question was not really one of pronunciation. He merely meant that we had as a matter of fact a literature at this moment in existence, and he thought that it was not possible in the present stage of civilisation to bring about a universal change, say, of a given letter. He also wished to say—and the Chairman knew it better than anybody—that when the printing reform of which he spoke came into operation it was all along the lines of simplicity and classic asceticism that it progressed. Looking at it as it applied to posters, one wanted a poster to be seen in a very different way from such a thing as a little Christmas card, it had to be seen in a flash. That was why the colouring was simplified and the ridiculous shading up that the old lithographic artists were so fond of was eliminated.

On the motion of the Chairman, a hearty vote of thanks was accorded to the author for his paper, and the meeting terminated.

POWER FROM NATURAL STEAM SPRINGS IN ITALY.

A very interesting experiment has been carried out at Larderello, in Tuscany, with extremely satisfactory results. At this point there is an area of about thirty-six square miles where, from time immemorial, natural steam springs have existed. As early as 1790 the presence of boric acid in the water condensed from the steam was detected, and for many years a company at Larderello has been producing boracic acid on a large scale. This company controls the entire district.

The natural steam was first used for evaporating the water from which the boracic acid is obtained. Wells are drilled and dry steam at a pressure of three atmospheres is found at a depth varying from 195 to 390 feet. At Larderello some of these wells have had an initial production of 154,000 pounds of steam per hour. In 1897 the natural steam was first used for heating the boilers of the company, and in 1905 a further step was taken when experiments were conducted with the steam in a piston engine. The results were so satisfactory, writes the United States Trade Commissioner at Rome, that a large engine was installed which is still in operation.

Having a very large surplus of steam in excess of that required for its own uses, the company referred to decided to utilise this excess steam for producing electric power. In 1912 a 250-kilowatt turbo-generator was installed—the natural steam being employed not directly in the turbine, but as a means of heating water for the production of the steam required; and in 1916 a large power plant, containing three units of 2,500 kilowatts each, was completed. A fourth unit will soon be added, which will give a capacity of 7,500 kilowatts, one unit being held in reserve. The boilers which are used are on the principle of the ordinary tube boiler, and consist of aluminium tubes contained in a shell of sheet iron. The natural steam at a pressure of about one atmosphere circulates outside the tubes, within which the pure steam is generated at a pressure of about one-half atmosphere. Each element is calculated to produce 13,200 pounds of pure steam per hour. The turbines, which were specially made by an Italian firm, have a maximum output of 3,000 kilowatts at 3,000 revolutions per minute—an actual net capacity of 2,000 kilowatts. Each turbine requires 77,000 pounds of steam per hour.

The principal power lines, which are at 36,000 volts, are as follows:—First, Larderello to Siena, connecting with the Valdarno system, which supplies eastern Tuscany, including Florence: second, Larderello to Leghorn; third, Larderello to Piombino, where important iron and steel works are situated; and fourth, Larderello to Massa, where there are iron and copper pyrites mines.

So far as the district of Larderello is concerned, the use of natural steam has solved the coal problem, which is such a serious one for other sections of Italy that have not been equally favoured by Nature.

PROGRESS IN TANNING FISH LEATHER.

Excellent progress in the tanning of fish leather is recorded by the United States Bureau of Fisheries, and a number of the difficulties in the way of the development of the industry have been overcome.

One company which is tanning fish skins has established a station in North Carolina and another in Florida for the capture of sharks and porpoises, and is meeting with success in its fishery for sharks. It is understood that the number of stations will be increased as rapidly as possible. Another company has recently acquired a site for a tanning establishment in Washington for the purpose of tanning the hides of sharks, beluga, hair seals, etc.

Samples of leather recently submitted to the Bureau show marked improvement in appearance over earlier samples. The leather is soft and pliable, and appears to have ample strength for many uses. Arrangements have been perfected for the Bureau of Standards to make tests of the leather products as to durability, porosity, tensile strength, pliability, water absorption, wearing qualities, etc.

The nets which the Bureau developed for the capture of sharks are proving successful, and are being adopted for the fishery. At the fishery stations the liver oil is being extracted and the flesh converted into fertiliser, so that none of the material is wasted.

NOTES ON BOOKS.

The Ancient Entrenchments and Camps of Gloucestershire. By Edward J. Burrow. Cheltenham and London: Ed. J. Burrow & Co., Ltd.

Anyone who has travelled through Gloucestershire must have been struck by the great number of ancient earthworks and entrenchments to be found there. Several of these may be traced to the period of the Roman occupation of Britain, but a large number seem to date back to 2000 B.C. or earlier. Mr. Burrow has made an attempt in the first part of this book to reconstruct the conditions of life amongst the camp-men, and has briefly traced the history of the country from the earliest days through the Roman period (he gives a striking sketch of the restoration of the Roman Villa at Chedworth) to the invasions of the Anglo-Saxons, the Danes, and the Normans.

The second part contains a series of drawings by the author of a very large number of the entrenchments and earthworks of the county, together with brief descriptions of each. These are arranged in alphabetical order. The preparation of this part must have involved a great deal of time and trouble; but the result is extremely interesting, and gives the reader a very good idea of the extraordinary wealth of archæological material to be found scattered throughout Gloucestershire.

The volume concludes with a useful map of the country, on which are indicated the sites of the principal camps and entrenchments described by the author.

GENERAL NOTES.

Sponge Gathering in Tunisian Waters.—Although the Greek divers have abandoned the sponge fisheries of the Tunisian coast for those of Tripolitan waters, unexploited since the Turko-Italian War, where, it is reported, unexcelled sponges have recently been taken, the sponge beds along the coast of Tunis are proving profitable to the Sicilian drag-nets and harpoonists now plying in the Gulf of Gabes and around the Kerkenna Islands. Sfax, the chief port of southern Tunisia, is naturally the trade centre of the industry—the sponge market of Tunisia, whence domestic and export prices are regulated. It is interesting to note, writes the United States Consul at Tunis, that for the fine sponges which the Kerkenna fishers obtain the Sfax prices are from 32 francs per kilo.; sponges from the Gulf of Gabes, of ordinary quality, fetch 27 francs per kilo. (formerly from 12–14 francs). The harpoonists are bringing in good sponges, poorly dried and cleaned, which are sold at 32 francs a kilo. in Sfax. The Kerkenna sponges are sold without any preparation whatever, the buyers themselves cleaning the delicate tissues. The price of these sponges, adds the Consul, will shortly be 50 francs a kilo.

Concrete Aggregates.—The Concrete Institute has recently collected, in tabular form, a variety of useful information on the properties of aggregates available in different parts of the country. The collection of this information has been made possible by the co-operation of a number of county and borough engineers, who have furnished particulars upon forms provided by the Institute. By this means a large amount of valuable information has been made accessible to all who are interested in concrete work, and who wish to ascertain what aggregates are available in any particular district. The investigation is not yet completed, but the tabulated information at present collected is open for inspection, free of charge, on application to the Secretary of the Concrete Institute, at Denison House, 296, Vauxhall Bridge Road, Westminster, S.W. 1.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoons, at 4.30 p.m.:—

May 12.—Graily Hewitt, "Rolls of Honour." Halsey Ricardo, F.R.I.B.A., will preside.

May 19.—John Somerville Highfield, M.Inst.C.E., M.I.E.E., W. R. Ormandy, D.Sc., and D. Northall-Laurie, F.I.C., "The Commercial Application of Electrical Osmosis." Alan A. Campbell Swinton, F.R.S., will preside.

Indian Section.

Thursday afternoon, at 4.30 p.m.:—

May 20.—Brigadier-General Lord Montagu of Beaulieu, K.C.I.E., C.S.I., "Roads and Transport in India." Lieut.-General Sir Herbert V. Cox, K.C.B., K.C.M.G., C.S.I., Military Secretary, India Office, will preside.

Monday afternoon, at 4.30 p.m.:—

May 31.—Albert Howard, C.I.E., M.A., A.R.C.S., F.L.S., Imperial Economic Botanist to the Government of India, "The Improvement of Crop Production in India." Sir Robert W. Carlyle, K.C.S.I., C.I.E., will preside.

Friday afternoon, at 4.30 p.m.:—

June 18.—Sir Valentine Chirol, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

INDIAN AND COLONIAL SECTIONS.
(Joint Meetings.)

Friday afternoons, at 4.30 p.m. :—

MAY 28.—PROFESSOR WILLIAM A. BONE, D.Sc., Ph.D., F.R.S., "Lignite."

JUNE 4. — PROFESSOR SIR JOHN CADMAN, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E., "The Oil Resources of the British Empire."

CANTOR LECTURES.

Monday evenings, at 8 p.m. :—

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.

Syllabus.

LECTURE II.—MAY 10.—The second lecture continues the subject in greater detail through a selection from the most characteristic works by Robert Adam, dealing more particularly with the interiors and decoration of his famous houses.

LECTURE III.—MAY 17.—The third lecture is devoted to Sir John Soane, and traces his relations to the movement begun by Robert Adam and to the Greek and Mediæval revivals. Soane's ideas on architecture and decoration are discussed in relation to his more important works. In conclusion, it is pointed out that three-quarters of a century is covered by the work of Robert Adam and John Soane.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 10 ... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. A. T. Bolton, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758-1837." (Lecture II.)

Surveyors' Institution, 12, Great George-street, S.W., 8 p.m. Mr. S. A. Smith, "Rent Problems."

Geographical Society, Kensington Gore, W., 5 p.m. Mr. G. Dobson, "Instruments for the Navigation of Aircraft."

TUESDAY, MAY 11 ... Illuminating Engineering Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8.15 p.m. Captain J. W. Barber, "Recent Developments in Portable Types of Cinema Outfits."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. Keith, "British Ethnology—The Invaders of England." (Lecture III.)

Photographic Society, 35, Russell-square, W.C., 7 p.m. Professor A. Findlay, "Some Properties of Colloidal Matter and their Application in Photography." (Lecture II.)

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. Dr. W. J. Dakin, "Fauna of Western Australia. III. Further Contributions to the Study of the Onychophora." 2. Mr. C. Forster-Cooper, "Chalicotheroidea from Baluchistan." 3. Dr. W. T. Calman, "Notes on Marine Wood-boring Animals.—I. The Shipworms (*Teredinidæ*)."

Colonial Institute, Central Hall, Westminster, S.W., 8 p.m. Mr. F. C. Wade, "Through British Columbia by Cinema."

Horticultural Society, Vincent-square, Westminster, S.W., 3 p.m. Sir Daniel Morris, "The Use and Relative Value of Trees in Great Britain."

WEDNESDAY, MAY 12...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Mr. Grailly Hewitt, "Rolls of Honour."

Aeronautical Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Major Linton Hope, "Flying Boat Hulls."

THURSDAY, MAY 13...Inventors, Institute of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.30 p.m. Mr. D. Leechman, "The Relations of the Inventor to the State."

Royal Society, Burlington House, W., 4.30 p.m.

University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Mr. T. C. Thompson, "The Scripts of Ancient Mesopotamia and their Decipherment: the Origin of our Alphabet."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. P. Graves, "Welsh and Irish Folk Song."

Historical Society, 22, Russell-square, W.C., 5 p.m. Mr. B. Williams, "Minorities in War Time."

Auctioneers and Estate Agents' Institute, 34, Russell-square, W.C., 3 p.m. Mr. E. H. Blake, "The Institute: A Glance into the Past."

FRIDAY, MAY 14...Federation of Laundry Associations, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 7.30 p.m.

Iron and Steel Institute, at the University, Sheffield, 3 p.m. 1. Messrs. J. H. Andrew, J. E. Rippon, C. P. Miller, and A. Wragg, "Effect of Initial Temperature upon the Physical Properties of Steel." 2. Messrs. C. A. Edwards, H. Sutton, and G. Oishi, "The Properties of Iron-Chromium-Carbon Steels." Part I., Thermal Analysis, Messrs. C. A. Edwards and A. L. Norbury, "The Properties of Iron-Chromium-Carbon Steels." Part II., "Effect of Heat Treatment on Electrical Resistivity." 3. Messrs. K. Honda and T. Murakami, "On the Structural Constitution, Hardening and Tempering of High-Speed Steel containing Chromium and Tungsten." 4. Mr. J. H. G. Monypenny, "The Structure of some Chromium Steels." 5. Mr. A. L. Norbury, "The Effect of various elements on the Electrical Resistivity of Iron." 6. Mr. F. Rogers, "Brittleness of Nickel-Chrome and other Steels" (Part II).

Royal Institution, Albemarle-street, W., 9 p.m. Professor J. K. Pearson, "Sidelights on the Evolution of Man."

Sanitary Institute, Town Hall, Scarborough, 7.30 p.m. Dr. J. R. Kayes, "Inconsistances in Personal and Communal Hygiene."

Malacological Society, at the Linnean Society, Burlington House, W., 8 p.m.

University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Dr. S. Ahmad Khan, "The Developments of Modern Educational Institutions in India." (Lecture II.)

Astronomical Society, Burlington House, 5 p.m.

Automobile Engineers, Institution of, at the Technical Institute, Coventry, 7.30 p.m. Mr. J. E. Hurst, "Cast Iron in relation to the Automobile Industry."

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m. 1. Dr. F. Lloyd Hopwood, "Demonstration of Experiments on the Thermionic Properties of Hot Filaments." 2. Mr. G. D. West, "A Modified Theory of Crookes Radiometer." 3. Mr. A. Campbell, "On the Magnetic Properties of Silicon-Iron (Stalloy) in Alternating Fields of Low Value." 4. Mr. T. Smith, "On Tracing Rays through an Optical System."

SATURDAY, MAY 15...Royal Institution, Albemarle-street, W., 3 p.m. Mr. F. Harrison, "A Philosophical Synthesis as proposed by Auguste Comte."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, MAY 17th, at 8 p.m. (Cantor Lecture.) ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." (Lecture III.)

WEDNESDAY, MAY 19th, at 4.30 p.m. (Ordinary Meeting.) JOHN SOMERVILLE HIGHFIELD, M.Inst.C.E., M.I.E.E., W. R. ORMANDY, D.Sc., and D. NORTHALL-LAURIE, F.I.C., "The Commercial Application of Electrical Osmosis." ALAN A. CAMPBELL SWINTON, F.R.S., will preside.

THURSDAY, MAY 20th, at 4.30 p.m. (Indian Section.) BRIGADIER-GENERAL LORD MONTAGU OF BEAULIEU, K.C.I.E., C.S.I., "Roads and Transport in India." LIEUT.-GENERAL SIR HERBERT V. COX, K.C.B., K.C.M.G., C.S.I., Military Secretary, India Office, will preside.

Further particulars of the Society's meetings will be found at the end of this number.

CANTOR LECTURE.

On Monday evening, May 10th, Mr. ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, delivered the second lecture of his course on "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837."

The lectures will be published in the *Journal* during the summer recess.

EXAMINATIONS.

The number of entries for the second series of examinations of 1920, which commenced on the 10th inst., and will finish on the 19th inst., is 36,326. The total entries for both examinations is 54,010. This is 19,834 in excess of the entries received in 1919, when the total for both examinations was 34,176. Previous to this year the highest number of entries received was in 1914, when the number was 37,978.

TWENTIETH ORDINARY MEETING.

WEDNESDAY, MAY 12th; Mr. HALSEY RICARDO, F.R.I.B.A., in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Booth, Frederick Augustus, Harborne, Birmingham.
Hegarty, R. D., London.
Kent, T. O., East Molesey, Surrey.
Miller, Frank, Beckenham, Kent.
Preater, Charles John, M.Inst.Met., Bath.

The following candidates were balloted for and duly elected Fellows of the Society:—

Anderson, Sir Alan Garrett, K.B.E., London.
Dunning, Major James, D.S.O., London.
Hart, Charles, F.S.S., Moseley, Birmingham.
Howard-Flanders, Richard Leonard, M.I.Ae.E., Latchingdon, Essex.
Kneass, Strickland L., Philadelphia, U.S.A.
Mayrow, J. J., London.
Sherrill, Brigadier-General Charles H., LL.D., New York, U.S.A.
Visvesvaraya, Sir M., K.C.I.E., M.Inst.C.E., London.

A paper on "Rolls of Honour" was read by Mr. GRAILY HEWITT, B.A., LL.B.

The paper and discussion will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

FIFTEENTH ORDINARY MEETING.

WEDNESDAY, MARCH 24th; SIR HENRY TRUEMAN WOOD, M.A., Vice-President and Chairman of the Council, in the chair.

The paper read was—

INDUSTRIAL LIGHTING AND ITS RELATION TO EFFICIENCY.

By Leon Gaster,
Hon. Secretary of the Illuminating Engineering Society.

Rather more than seven years have elapsed since I had the honour of addressing the Fellows of the Royal Society of Arts on the subject of industrial lighting, emphasising especially the economic and hygienic advantages of good illumination. It is now my privilege to give a further summary of progress made in this field. The Royal Society of Arts has invariably been to the fore in dealing with matters affecting the welfare of workers and the efficiency of industrial operations. It has interested itself in such matters as heating and ventilation, and by inviting me to deliver the series of Cantor Lectures on "Modern Methods of Artificial Lighting," in 1909, it had already given its approval to the principle that all illuminants ought to be considered conjointly, with a view to their proper application in practice to the service of mankind.

In little more than a year after my last paper before the Society on "The Economic and Hygienic Advantages of Good Illumination," the outbreak of war took place. Events during the subsequent five years, while in some respects retarding scientific development of illumination, served to emphasise the great importance of adequate industrial lighting in the interests of health, safety and efficiency. There is no industry in this country which does not involve the use of light as a necessary element in production. During a period when the factories of the country were striving to produce their maximum output, this point was inevitably recognised, and at the present time there are several industrial tendencies which make it specially important that the influence of lighting should be properly studied.

We are concerned with two inter-related problems. There is a general recognition that we must increase our powers of production to the utmost. At the same time there is industrial unrest which impedes our efforts towards reconstruction. Lighting, as I shall show, has an important bearing on both aspects. It is intimately connected with efficient production, but it should also be considered in relation to conditions of labour from the worker's standpoint. When conditions are bad there is inevitably discontent, and there is little doubt that in the past unsatisfactory lighting has increased this tendency by adding to the hardships and dangers of many industrial operations. Moreover, it will be generally agreed that our industrial problems should be ultimately solved in such a way that the worker has every incentive to increased production. The one dangerous factor is deliberate restriction of output.

In the future, therefore, output must be assisted in every possible way. There are several tendencies already operating in this direction. One of these may be the extension of the "three-shifts" system, whereby the hours of labour can be shortened, but the machinery used in the most efficient manner. As Lord Leverhulme has put it, we must "sweat the machinery, not the workers." Now the extension of this system means the carrying out of an even larger proportion of work by artificial light than at present. During the war the proportion of work done by artificial light increased greatly, owing to the need of getting more work out of existing plant and factory space. We may expect this method to become more general, but it will only be successful if special pains are taken to ensure that the lighting is scientifically designed for the work; so that ultimately work by night may be no less efficient and no more fatiguing or dangerous than work by day.

Another tendency is towards the standardisation of industrial processes. This intensive production demands specially good lighting, because the failure of any link in the process disorganises the whole. Bad lighting, besides slowing down some stage in the process, is liable to cause harassing breakdowns and disorganisation. In such processes, parts must be not only accurately made, but interchangeable, and this perfection of work can only be attained when the light is scientifically directed and adapted to the purpose in view. During recent years the order of accuracy demanded has become much greater than in the past. It involves the use of the finest tools, maintained in perfect condition. Among such tools, light is one of the most important and most universally employed.

I now propose to consider in turn the influence of illumination on health, accidents, and efficiency of production, and subsequently to explain some of the chief principles of good lighting, and to suggest measures to secure it.

Industrial Illumination and Health.

The close relation between light and health

has long been recognised by physicians. It is known that absence of light is favourable to the development of tuberculosis and certain other diseases, besides increasing the risk incurred in various dangerous trades. In the case of such trades, notably those concerned with vitreous enamelling and in underground bakeries, the Home Office regulations in this country have, for many years, required good lighting. Moreover, employees work more cheerfully in well-lighted premises, whereas dark and gloomy surroundings are depressing to the spirits. It has also been found that where the lighting is good, more attention is paid to cleanliness and personal appearance. In all ill-lighted factories refuse is apt to collect, whereas in a well-lighted interior its presence would be obvious, and it would be accordingly removed. Naturally, when poisonous materials have to be handled, the risk to health is greater if workers cannot see clearly refuse-material which collects on their work and persons. In those cases where work is necessarily done to a great extent by artificial light, and especially where, owing to the large area occupied, it is impracticable to reproduce the conditions prevailing in a well-lighted factory, the risk of ill-health is particularly great.

Furthermore, bad illumination enormously increases the effort of working, especially work that makes a severe tax on the eyesight (*e.g.*, in the clothing, sewing, and textile and embroidery trades). This strain may show itself in various ways in the form of headaches, eyestrain, or general lassitude. The investigations carried out on industrial fatigue have shown, by delicate tests, how vitality is gradually sapped during a severe day's work, and how recuperation sets in during the night's rest. These data have furnished strong evidence in favour of the limitation of hours of work, and the provision of reasonable pauses for recuperation. When to the normal strain of exacting work there is added the additional effort imposed by inability to see the work in comfort, or to follow with ease the working motions of complicated machinery, it can readily be judged how the period before fatigue sets in may be shortened. The effect of inadequate lighting in thus causing fatigue is one subject that might well receive attention from the recently formed Research Board appointed by the Department of Scientific and Industrial Research and the Medical Research Committee last year. The field of work of this Committee covers a general survey of the relation of hours of work and other conditions of employment to the production of fatigue, having regard both to industrial efficiency and the preservation of health.

We have, however, already important evidence indicating generally the prejudicial effects of inadequate lighting, although this matter requires further study in detail. At the time of my paper before the Royal Society of Arts in 1913, the Departmental (Home Office) Committee on Lighting in Factories had already been formed, and its researches were being conducted. It will be recalled that Sir Arthur Whitelegge, then H.M. Chief Inspector of Factories, and a member of this Committee, presided at the meeting of the Royal Society of Arts at which the paper was delivered. In 1915 the Committee issued a most comprehensive interim report, to which I shall frequently have occasion to refer, and in which the detrimental effects of inadequate lighting were very clearly recognised. The Committee in this report remarked:—" . . . there is a general impression that unsatisfactory lighting is, in various ways, prejudicial to health. It is also recognised that insufficient light adds to the difficulty of the proper supervision of work, and of the maintenance of cleanliness and sanitary conditions generally."

During the war there were many opportunities of confirming these impressions, owing to the large number of factories under State control and under special supervision. Most valuable work in studying the conditions in such factories was done by the Health of Munition Workers Committee (M.O.M.), and I cannot do better than also quote some of the conclusions of this Committee, as set out in its booklet on "The Health of Munition Workers":—

"The results of inadequate illumination are damage to eyesight and personal health, various forms of domestic insanitation, accidents in factories and workshops, often accompanied by diminution in output of work and lack of discipline. Bad lighting affects output unfavourably, not only by making good and rapid work more difficult, but by causing headaches and other effects of eyestrain."

The special question of the effect of inadequate lighting on output, which is an economic one, will be dealt with more fully later. But it is at once apparent that there is a double case for the provision of adequate lighting in the interests of health. The case rests primarily on humanitarian grounds, that it is intolerable that workers should be exposed to injurious conditions; but, in addition, the case for good

lighting, as we shall see, is equally strong from the purely economic side.

The next question we shall consider, the effect of inadequate illumination in causing accidents, is closely related to that with which we have just dealt. It may be taken for granted that, where possibilities of accidents exist, the dangers are accentuated if the illumination is such as to affect the health of workers prejudicially. There are, however, special precautions to be taken in connection with illumination, according to the nature of the processes carried on.

Bad Illumination as a Cause of Accidents.

For some years the part played by poor conditions of illumination in causing accidents has received study, and there is already available a great deal of information on this point. It is obvious that accidents, which so often arise from failure to perceive, will often be associated with inadequate illumination. Cases on record include men carrying molten metal in ironworks, who have stumbled over unseen obstacles and injured themselves with the hot metal; men working in feebly lighted workshops, who have failed to see clearly the outlines of moving machinery, and become entangled with it; men working in dockyards or on scaffolding, who have lost their footing because the illumination was not sufficiently well devised to reveal loose planks or pits, etc.; men working on railways or in yards, who have been run over by trains, trolleys, etc., because the lighting was not adequate. In many cases accidents are due to insufficiency of light, but they may be due to other defects; for example, the dazzling effect of a bright light in dark surroundings, or the confusing shadows or abrupt transition from brightness to darkness caused by imperfectly diffused sources of light. Steep stairs and raised platforms with exposed edges, should always be well lighted. It is not enough merely to secure sufficient illumination on the area in question; *the light should be shaded so that the worker's eyes cannot be dazzled by the glare.*

Of all forms of accidents liable to be caused by inadequate lighting, special prominence may be given to those arising through "persons falling." This was strongly brought out in the data collected by the Departmental (Home Office) Committee on Lighting in Factories and Workshops, which reported in 1915. It was shown that such accidents are much more prevalent during the darker winter months than in the summer time. For a large number of industries the accident rate by night and by day was studied. Almost invariably the rate by night was considerably higher, the average increase for all industries being 29 per cent. for all forms of accidents, and 71 per cent. for persons falling. In the case of docks, where this type of accident is common, the increase was 102 per cent.

Some valuable confirmatory evidence was given by Mr. R. E. Simpson recently before the Illuminating Engineering Society in the United States. In that country also the number of accidents in each month of the year has been tabulated, and the same conclusion reached. A careful survey of industrial accidents and lighting conditions might enable us to correct many existing faults, and bring the accident rates by night and day into closer equality. Theoretically there seems no reason why artificial lighting in most factories should not be as suitable for the purpose as average daylight. Indeed, artificial light has the advantage of being strictly under control, capable of adjustment between wide limits, and, once installed, much more constant than natural lighting, which varies enormously according to climatic conditions.

The conditions of access of daylight into buildings, I need scarcely add, also require careful treatment, so much so that the general arrangement and shape of modern factories is very largely governed by this consideration. It would be of great assistance to the lighting expert if architects, in planning buildings, would likewise bear the requirements of artificial lighting in mind, and confer with the illuminating engineer at an early stage in the design.

In the United States much excellent work has been done by "Safety First" Committees, established by many leading manufacturers to examine and correct causes of industrial accidents. On such committees both employers and workers are represented, and remarkable reductions in the number of accidents have been made by their efforts within quite a short period. Thus on all American railways, deaths and injuries were reduced by 46 per cent. in 1916, and large industrial concerns have recorded decreases ranging from 24 per cent. to 84 per cent. since the movement was initiated. The "Safety First" movement in the United States receives very powerful support. Lord Leverhulme, who mentioned this fact in summarising his experiences during a recent visit to the United States, has also stated that

the beginning of the "Safety First" movement was made in this country; it is only in recent years that developments in the United States have proceeded more rapidly than here.

However, since the outbreak of war the matter has been energetically taken up by the London "Safety First" Council, and its off-shoot the British Industrial "Safety First" Association. The valuable work which these bodies have already accomplished is very largely due to the energy of Mr. H. E. Blain, one of the hon. secretaries, and the moment was certainly opportune for the inception of this work. The great losses suffered by this country during the war render it of vital importance to take all possible measures to check the continuous drain on our resources through accidents to life and limb. Two years' work by the London "Safety First" Council, in connection with street accidents, has been accompanied by a decrease in fatal accidents of 24 per cent., and in accidents to persons and property of 36 per cent. By the formation of the British Industrial "Safety First" Association, which has just completed its first year of existence, this work has now been extended to the industrial field. Machinery is being prepared to facilitate an analysis of the causes of accidents in factories, amongst which inadequate lighting takes an important place. At a meeting of the Illuminating Engineering Society in 1918 the author presented a table showing how the necessary data could be obtained on a uniform basis, and there is no doubt that by the application of a schedule of this description, much valuable information as to the part played by industrial lighting conditions in relation to accidents might be obtained.

One of the first steps taken in this direction by the British Industrial "Safety First" Association has been the issue of a publication explaining in simple language the part played by lighting in relation to health, safety, and efficiency, and the fundamental principles to be applied in order to secure adequate illumination.

An attempt to trace the relation between inadequate illumination and accidents has also been made in the United States. Mr. R. E. Simpson, in the paper referred to above, quotes statistics obtained by the Travellers Insurance Co., who estimated that of 91,000 accidents studied in 1910, 23·8 per cent. were due to imperfect illumination. After eight years' work this proportion has been reduced to 18 per cent., but even so it is estimated that during this period the services of 108,000 men for one year have been lost through preventable accidents.

In this country the Home Office statistics for 1914 showed that 969 persons were killed and 147,045 injured in factories alone, and this refers to reported accidents, and does not include a large number of minor accidents. The official returns under the Workmen's Compensation Act for 1913 showed that £3½ million were paid in respect of nearly 4,000 deaths and 477,000 disablement claims. If, by the application of scientific principles of lighting, a reduction of only 10 per cent. in this large figure could be made, it would be well worth while, especially when the secondary economic loss through time wasted and disorganisation is also taken into account.

The prevention of industrial accidents due to faulty lighting is thus a measure which is amply justified on economic grounds alone, besides being, of course, a measure which ought to be taken in the interests of humanity.

I shall now proceed to consider the effect of illumination on the quality of work and output. For various reasons it is not so easy to trace a direct monetary advantage from good lighting as to show its effect on health and in preventing accidents, but there are data available which justify the belief that these advantages far outweigh the cost involved.

The Effect of Illumination on Output and Efficiency.

It is evident that failure to provide adequate illumination greatly increases the difficulty of supervision and accentuates the tendency to slackness, where this exists. On the other hand, good lighting has a bracing effect and inclines men to put out their best efforts. It is clear, too, that a skilled worker cannot put forth his best efforts if he is hampered by difficulty in seeing what he is doing, and that it is folly to pay high wages and instal expensive machinery and then to grudge the relatively small expenditure necessary to put the lighting on a proper basis. The high order of accuracy, the high speed of machinery, and the use of automatic methods make the results of inadequate lighting specially serious. If a tool is wrongly set, a great deal of work may be turned out before the error is rectified. Bad lighting reveals its effect both in slowing down operations and in increasing the amount of spoiled work. This applies alike to engineering operations where things must be made to exact dimensions, and to textile processes where the surface of the

material must be carefully studied. Good lighting is essential for the inspection of materials, but an injustice is done to the workers if the lighting conditions by which they execute the work are not as good as those by which the work is subsequently inspected.

Evidence of increased output following improvement in illumination was given by several witnesses before the Departmental Committee on Lighting in Factories and Workshops. In one case noted the earnings of workers increased 11·4 per cent. after the installation of better lighting; in another case the output by artificial light, owing to faulty methods of illumination, was 12·30 per cent. less than by daylight. The matter is of equal interest to managers and employees. The latter are quick to appreciate the connection between good lighting and earning power. Thus it was stated by Mr. Franklin Thorpe, in a paper read shortly before the war, that in the North of England workers tend to migrate continually to the better lighted mills. It is a common experience that when the lighting of one section of a factory has been improved, workers in other sections also clamour for a similar improvement. Moreover, whilst managers and workers are sometimes slow to admit the full economic benefits of good lighting, one finds that, once an improvement is made, neither will consent to return to the old conditions.

In order to trace scientifically the relation between lighting and output, it is necessary to conduct special experiments in factories for the purpose. Naturally, managers are reluctant to disturb their routine, although in many cases the experience gained would fully justify any loss occasioned by change of procedure. An interesting experiment was recently conducted in Chicago by the Commonwealth Edison Company, which, like other American supply companies, also supplies lamps and fittings and can therefore readily make a survey of lighting conditions. A survey was made of ninety-three factories, totalling 17,400 employees. Wide variations in illumination and consumption of electricity were found, but an average of 1½ foot-candles,* 0·33 watts per square foot, and 80 watts per employee were noted.

Now, according to the code of lighting adopted by the Illuminating Engineering Society in the United States as representing good modern practice, the average illumination should have been 5·5 foot-candles, and the variation in illumination, according to the process, which was actually 0·01–10 foot-candles, should have been 2–12 foot-candles. A programme of experiments, covering four months, and taking full account of both lighting conditions and output, was then arranged. The first month was to run with the existing lighting, the second month with lighting to a value of illumination 50 per cent. above that required by the code, the third month at the lower code level, and the fourth month again at the higher illumination.

The chief difficulty was to find factories which could maintain the requisite check on output, and to induce owners to return to the lower illumination for the purpose of test, after the illumination had once been raised. But tests have already been made on eleven plants, and in some cases remarkable results secured. Thus, in one case the improved illumination resulted in an increased output ranging from 8 to 27 per cent. in different departments when the illumination was increased three times, *i.e.*, from 4 to 12 foot-candles. In another case, where the illumination was twenty-five times the inadequate value originally employed, increases in output of from 30 to 100 per cent. were observed. On a conservative estimate it was concluded that an *increased cost of lighting amounting to not more than 5 per cent. of the pay-roll would lead to an increased production of quite 15 per cent.*

This remarkable experiment, conducted last year, gives a glimpse of the important effect which illumination may exercise on output. No doubt a painstaking investigation in this country would yield equally striking results. Tests conducted on the above basis are necessarily spread over a long period. But supplementary results could be obtained by quicker methods; for example, by timing with a stop-watch the time taken for various industrial processes by the existing illumination, and again when the lighting had been improved. By continual adjustment of lighting conditions and repetition of this test, the ideal conditions would ultimately be obtained.

At present experience shows that there is no consistency in the lighting of factories. One finds in different works great variations in the amount of illumination provided for identical processes. Evidently either some of the factories are inadequately lighted, or others are extravagantly lighted. It seems likely, however, that in most cases the amount of illumination could

* A foot-candle is the illumination produced by a source of one-candle power at a distance of one foot. It is possible to specify and measure the illumination in foot-candles at any spot, quite irrespective of the number and arrangements of the lights producing this illumination.

with advantage be increased without trespassing beyond the upper limit beyond which an increase in the amount of light has no marked economic advantage.

Some simple experiments, which would serve as a model for more detailed investigations, were made by the National Physical Laboratory in connection with the researches of the Departmental Committee on Lighting in Factories and Workshops. The experiments were made with seamstresses from the workrooms of some of the chief London outfitting firms, the illumination being first adjusted to a value which was admittedly too low for efficient working, and then raised until there was agreement that the amount of light was sufficient. By repeating this experiment, the necessary minimum illumination for comfortable work was ascertained with fair accuracy. A point of great consequence is the nature of the material worked with. Thus black material required 5 to 6 foot-candles, whereas with white cloth a much lower value appeared sufficient. Roughly, the product of the necessary illumination on work and the reflecting power of the material remained constant. In other words, there was a *minimum brightness of material necessary* for efficient work.

Cost of Lighting in Relation to Wages and Equipment.

The economic advantages of proper industrial lighting are again emphasised when one considers the proportion that the cost of lighting forms of other industrial expenses. Mr. Clewell, in a recent article in "Industrial Managements," took as a typical example a room with a floor area of 3,000 sq. ft., in which twenty-five employees were at work, earning on the average 25 cents (approximately 1*s.*) an hour. The total annual wages bill for this area might amount to \$25,000 (say £5,000), including superintendence and overhead charges. The annual cost of lighting the area should not exceed \$250 (say £50), from which it appeared that the lighting costs only 1 per cent. of the wages bill. Naturally, the exact proportion will depend on the wages paid, but it is invariably small. If all the other items forming standing charges on the factory were included, the proportion would be smaller still. Only a very small improvement in output would be needed to compensate for the cost of better lighting, quite apart from the other advantages referred to previously, such as better health of employees, less fatigue and nerve strain, etc., all of which are difficult to assess commercially.

The results are equally striking if one compares the cost of *installing good lighting* with the total cost of the erection and equipment of large factories. Thus Mr. Clewell found that in the Ford Motor Works in the United States the cost of buildings and equipment amounted to \$1·64 (say 6*s.* 6*d.*) per sq. ft. of floor area, while the lighting installation cost 5 cents (approximately 2½*d.*) per sq. ft., *or only* 3 *per cent. of the entire first cost.* In this case also the running costs of lighting were small in comparison with the total operating charges, forming only about $\frac{1}{10}$ per cent.

Those cases in which managers are disposed to grudge adequate expenditure on lighting may be due to inability to perceive the vital bearing of good illumination on efficiency of work. Another point, especially in the case of factories running almost continuously, is the disturbance which an alteration in the existing lighting necessarily causes. The manager must therefore weigh against the inconvenience of a temporary stoppage of part of the factory, the advantages which will ultimately accrue through the improved lighting. But in the case of a *new* installation this difficulty does not occur, and there is every reason for advocating the most careful and scientific planning of the lighting in such cases.

I may also add, that improvements in lighting do not necessarily involve greater expenditure. In many cases the advantages of better illumination may be secured by a re-arrangement of existing installation, a better choice and application of lighting appliances, and by the consequent avoidance of waste of light that arises from such appliances being injudiciously used. In such cases the advantages to the manager are twofold. He obtains the benefit of economies in the use of gas and electricity, and the further gain of the better conditions of working secured as a result of the improvement in lighting made.

Some Important Points in Good Industrial Illumination.

Having shown the justification for proper industrial lighting, let me next refer to some of the most important principles involved. Scientific illumination is only obtained when lighting is studied in relation to the processes carried on. *The lighting expert needs to be familiar with these processes as well as his own speciality, the principles of illumination.* But as a result of the discussions before the Illuminating Engineering Society during the past ten years, the fundamental principles have been clarified, much

information on special lighting problems has been obtained, and there are now men in a position to give good advice.

One important element in progress has been the development of simple forms of instruments for measuring illumination. By means of many measurements of illumination in factories we have ascertained what great variations in illumination exist, and where waste occurs. We are able to verify, by actual measurement, estimates of the illumination to be provided. Above all, we know the existing order of illumination prevailing in factories, and can determine when recommendations are practicable. Thus the large number of measurements, upwards of 4,000, made by the Departmental Committee on Lighting in Factories and Workshops was extremely helpful in fixing standards.

Good lighting, however, is not merely a matter of providing sufficient illumination. Other important points include:—Uniform illumination over the working area; the placing or shading of lamps so that the light does not fall directly in the eyes of workers when engaged on their work, nor when looking horizontally across the workroom; the placing of lights so as to avoid the casting of inconvenient extraneous shadows on the work.

The choice of suitable forms of reflectors, so as to secure even illumination and absence of troublesome shadows, is of great importance. Light tinted walls and ceilings are of great assistance in eliminating such shadows and promoting good diffusion of light.

It is most desirable that lamps, reflectors, etc., should be regularly cleaned and maintained. A few months' neglect may result in a loss of as much as 50 per cent. of the working illumination, and cases are on record where, by merely making good defects and cleaning lamps and appliances, the available illumination was doubled.

During the war manufacturers were so fully occupied in meeting demands for standard types of lamps and reflectors, etc., for essential work that there was not much opportunity for introducing new designs. Much attention has been devoted to industrial lighting, and the illumination of munitions works. It was fortunate that the leading firms concerned with lamps and lighting appliances had already formed illuminating engineering departments, and could thus both supply lighting apparatus and advise on its use. Here the country reaped the reward of the work of the Illuminating Engineering Society in the years preceding the war. Both gas and electric lighting have played a great part in promoting industrial progress. A feature of modern methods is the use of the latest and most efficient units, such as high-pressure gas or gas-filled ("half-watt") electric lamps, placed high up out of the direct view of workers, and affording a clear space for the supervision of the workroom. The electric gas-filled lamp, comparatively unfamiliar at the outbreak of war, has since been much used for industrial lighting, and great care has been devoted to the design of special fittings for use with this form of lamp. Amongst such devices may be mentioned the air-tight forms of lanterns suitable for use in munitions works, or placed where chemical fumes are present.

Lighting Conditions in Mines and the Eyesight of Miners.

Lighting in mines forms an important section of industrial lighting. Miners, however, are almost entirely dependent on portable lamps for the working illumination, which is thus far below the value usual in factories. In my paper before this Society in 1913, I referred to the effect of these peculiar conditions on the eyes of miners, especially in causing "miners' nystagmus." At the present time the prevalence of this disease still gives ground for much concern. Dr. T. L. Llewellyn, in a paper before the Illuminating Engineering Society on February 24th, 1920, estimated that upwards of 6,000 men are disabled each year through this disease, with a corresponding economic loss to the country exceeding £1,000,000. In the discussion of this paper, eminent representatives of the Council of British Ophthalmologists and the Ophthalmological Section of the Royal Society of Medicine took part, and there was general agreement that inadequate illumination is an important factor in causing the disease. Dr. Llewellyn suggested, as a first step, a standard of illumination on the working surface of not less than 0·1 foot-candles—a value with difficulty obtainable from lamps in use prior to 1914. It was suggested that the question should be thoroughly studied by a joint committee on which the Illuminating Engineering Society, the Council of British Ophthalmologists, and the Royal Society of Medicine should be represented. There is now sitting, under the Home Office, a committee which is making investigations on miners' lamps, and the suggestion will doubtless receive sympathetic consideration from this Department, which has done so much to encourage good lighting in factories. The problem is a highly complex one, involving inquiries extend-

ing over a number of years, in order to obtain satisfactory results.

Government Action on Industrial Illumination.

In my previous paper before the Royal Society of Arts in 1913, I detailed some of the steps taken by Governments in various countries in regard to industrial illumination. Holland, as far back as 1895, required adequate lighting in general terms, and in 1911 laid down more precise rules for lighting in factories where young people are employed, including a minimum illumination of 2–3 foot candles, according to the process.

In this country, strange to say, there has been no specific requirement of adequate lighting in the Factory Acts, although such a requirement was introduced into the Indian Factory Act in 1911, and occurs in the legislation of New South Wales. However, in certain trades definite requirements have been made, and actually a great deal more attention has been paid to industrial lighting than a mere inspection of the Factory Acts would suggest.

During the years preceding the war, the need of dealing with the matter on more comprehensive lines was recognised in several countries, notably at several international congresses, to which I referred in my previous paper in 1913. The report of the British Departmental Committee on Accidents in Factories and Workshops, issued in 1911, recommended that "general statutory power to demand adequate lighting" should be conferred on the Home Office. In the same year the Minister of the Interior in France appointed a Committee on Illumination; and early in 1913 the Home Secretary in this country announced the formation of the Departmental Committee on Lighting in Factories and Workshops. Shortly afterwards the Académie Royale de Médicine Belgique requested the Government to form a similar committee in Belgium.

In France and Belgium the outbreak of war interfered with the continuation of these inquiries, but the Committee in this country persevered with its work, issuing an interim report in 1915, which is justly regarded as a landmark in the official treatment of industrial lighting.

This report endorsed the recommendation that there should be statutory provision for requiring adequate and suitable lighting in factories, and giving power to the Secretary of State to make orders defining such conditions. It also contained specific recommendations on the amount of illumination necessary in the interests of safety, but deferred for further consideration the question of the illumination needed for various processes of work. This country can justly claim to have been in advance of others in carrying through this valuable inquiry, but owing to the interruption of work caused by the war the carrying out of the Committee's recommendation with regard to the insertion of a definite requirement of adequate lighting in the Factory Acts was deferred.

It is curious that in this matter, as in the case of the "Safety First" movement, this country did the pioneering work, but, judging from the vast amount of published literature in America it might appear that this country had fallen behind in the development of the original idea. In the course of a visit to the United States in 1912, I gave a summary, before the Illuminating Engineering Society in that country, of progress in Europe, dwelling chiefly on the need for official recommendations on industrial lighting. The idea has since been adopted with enthusiasm in the United States, and, being relatively unhampered by war conditions, that country was able to profit by the experience of Europe. There are now six States—Pennsylvania, New Jersey, New York, Wisconsin, Oregon, and California—which already possess definite codes of industrial lighting, while others are expected to adopt similar procedure in the near future.

The various codes are based largely on that prepared by the American Illuminating Engineering Society, and follow closely the recommendations of the Home Office Departmental Committee in this country. In some respects they are more explicit, *e.g.*, in stating definite values for various kinds of work, besides general values in the interest of convenience and safety. The codes appear to have worked well. Manufacturers have proved anxious to comply with their requirements, and the chief need has been for educational measures to ensure that they are properly understood. Thus the Museum of Safety in New Jersey contains exhibits of various lighting systems. (This is a step which, I believe, was contemplated by the Industrial Museum in this country immediately before the war, under the supervision of the Home Office. The building was complete, but was necessarily converted to war needs, but one may hope that it will now revert to its proper use.) In New York, again, factory inspectors attend a departmental school, where the results of tests of lighting installations are presented and discussed.

In order to show that these codes are in actual operation, the following table, presented by Mr. Vogt, of the New York State Labour Department, in a recent discussion before the American Illuminating Engineering Society, is of interest:

	Orders issued.	Compliances.
August, 1918	35	27
September, 1918	174	67
October, 1918	611	88
November, 1918	546	156
December, 1918	446	205
January, 1919	608	517
February, 1919	765	506
Totals	3,185	1,566

Thus the proportion of compliances steadily increased, and 50 per cent. of orders for improvements made during this period have already been met.

Now, in the United States each State acts on its own initiative, and although the general principles adopted in the industrial codes are substantially similar, the procedure is not identical. This, it is pointed out, is illogical; while the more progressive States have adopted legislation, the great majority still have none.

In this respect Great Britain is in a more fortunate position, and I am anxious that this country should maintain the lead which it formerly held in this matter. The action taken by the Home Office would apply generally throughout the country, and it only remains to translate the recommendations of the Departmental Committee into actual fact. Our knowledge has considerably advanced since the year 1915, when the report of this Committee was issued, and it is only now desirable to continue its interrupted work so that other matters not yet reported upon may also be settled.

Indeed, so rapid is the development of knowledge on lighting matters, that it may be urged that a Committee of this description should be a permanent one. However satisfactory the recommendations of the moment may be, they are sure to require modification and extension in the future as our facilities for lighting improve and our knowledge of what constitutes good illumination becomes more perfect.

The essential point is that good lighting should now be regarded as of vital importance to safety, health, and efficiency of work, in the same manner as adequate heating and ventilation, and that a definite requirement of adequate lighting should be inserted in the Factory Act to this effect.

International Action on Industrial Illumination.

We should, however, not be content with securing suitable action in regard to industrial lighting in this country. In the long run it is always a drawback to civilisation when some nations are far behind others in development; the more general the practice of sound principles the better for everyone.

In my paper before this Society in 1913, already indicated the desirability—which was strongly endorsed by the Chairman of the meeting, Sir Arthur Whitelegge—of Committees being formed in all the chief countries of the world to deal with industrial lighting, and the interchange of experience between them, thus paving the way for international action. These expectations would doubtless have been realised but for the disturbance caused by the war. Experience during the war has greatly stimulated the desire for international co-operation, and it may be foreseen that in the near future there will be international machinery for dealing with this and other industrial questions. We see already indication of such international action in the work of the Committee that has been sitting in Paris in order to deal generally with labour conditions. In conferences of this nature one would like to see this country, which has behind it such a fine record for enlightened action in regard to industrial hygiene, again taking the lead in dealing with illumination.

One point, in conclusion, I should like to emphasise—that these measures for promoting good industrial lighting will, if wisely contrived and administered, meet with general good-will. The step is not a sudden one, but it is based on experience gradually accumulated during the past ten years. There is now such a general recognition of the importance of good illumination as a means of preserving health, preventing accidents, and improving output, that managers and workers alike will welcome measures likely to bring about an improvement. It will be essentially a case of "government by consent."

We in the Illuminating Engineering Society have always adopted this principle in suggesting measures for the improvement of existing practice in illumination. It will doubtless commend itself to the Royal Society of Arts, to whose sympathetic encouragement we owe so much. I would like to express my personal appreciation of the advice and help we have received from Sir Henry Trueman Wood, and it is a great pleasure to me that he is able to preside. This principle of securing general consent and approval before taking action has been largely instrumental in securing for our movement such generous assistance from the daily and technical

Press, whose help in making our objects widely known I desire also to gratefully acknowledge.

Since the Illuminating Engineering Society has taken charge of the subject of illumination, the Royal Society of Arts, in accordance with their usual practice in the case of special bodies formed under their wing, has left to us the working out of details in this field. We, in turn, gladly take the opportunity, as occasion arises, to bring before the Society surveys of general progress in the lighting field. I hope that in years to come I may have the privilege of recording further advances both in the efficiency of lighting appliances and in their application in the service of mankind.

DISCUSSION.

THE CHAIRMAN (Sir Henry Trueman Wood), in opening the discussion, said Mr. Gaster had added one more to the list of papers he had read before the Society, for the first of which, given in 1906, he had obtained, and thoroughly deserved, the Society's Silver Medal. His most important contribution was a course of Cantor Lectures on Illumination, which were remarkable for the excellent way in which they were illustrated. The formation of the Illuminating Engineering Society resulted from those lectures. That Society had been founded by Mr. Gaster, and he had been its moving spirit ever since. It had done an infinity of good work by bringing together the clashing interests dealing with illumination, and by disseminating knowledge on the subject. In his present paper Mr. Gaster had brought together a great deal of most valuable information; and the general conclusions at which he had arrived would, he thought, be generally accepted. As to whether legislation was required or not, he could not personally offer an opinion, but it was, at all events, a legitimate subject for discussion whether the supervision of factory lighting should not be brought into the scheme of factory inspection. The amount of light required in various industries varied considerably, and that was a difficulty which would have to be faced if legislation were to be introduced. The ideal condition would be to have sufficient artificial light to be an alternative to daylight, and that, of course, had an important bearing on a question which he hoped would be further urged and developed—the use of shifts of workmen, so that the untiring machine might work the full twenty-four hours, while the workman himself would only be forced to labour for such time as suited his health and convenience. Before such a scheme could be introduced, however, the work-people would have to be convinced that they would be given a fair share in the benefits resulting from the economy so effected. In the past the benefits of any increased economy had gone to the capitalist, and the workmen were apt to think that that would be the case in the future. They had to be shown that if the scheme to which he had alluded was introduced they would get a fair share of the profits resulting from it, and obtain increased wages and decreased hours of labour. There were numerous other points in the paper, but he would leave them to discussion by technical experts who were competent to offer an opinion on them. He should have liked to have heard a little more about the construction of the apparatus Mr. Gaster had mentioned for measuring the amount of diffused light in a factory. There were many devices which might be used, and there ought not to be any difficulty in making an apparatus which could be carried in the pocket and yet be used to obtain quite good, if approximate, results.

DR. T. M. LEGGE (Medical Inspector of Factories) joined with the Chairman in thanking Mr. Gaster for his paper and for the lantern-slides accompanying it, which gave an excellent idea of what good illumination really meant. All progress was largely the work of enthusiasts, and he thought all those present would agree that Mr. Gaster was a man who knew his subject thoroughly, and who both in season and out of season would never let them forget that illumination was one of the most important things to be considered in factory construction. Mr. Gaster had referred to the Home Office Report, and had expressed a hope that the question of factory illumination might find a place in any new Factory Act. Such an Act could not be long delayed, and in it he hoped factory illumination would be referred to by a simple reference to the provision of adequate lighting, which was the way in which, he thought, Mr. Gaster would prefer to have it dealt with. Under the Act* of 1916 the Home Office had issued a number of brochures on such subjects as the Provision of Canteens, First Aid, Ventilation, and so on, and amongst them there was in preparation one on Lighting in Factories and Workshops, which would cover much of the ground traversed by Mr. Gaster that afternoon, and would deal with a great many of the points alluded to in the paper, such as health and efficiency of the workers, necessity of good lighting in regard to efficiency of work, prevention of glare, avoidance of shadows, etc., and finished up by giving the causes of, and remedies for, unsatisfactory lighting, which to a large extent could be summarised by "common sense." The only point of difference he had with Mr. Gaster was with reference to the fact—if it was a fact—that America was so far ahead of this country. Having just returned from the United States, and after having visited several towns and factories there, he dissented rather from the view expressed by Mr. Gaster that the Americans were so far ahead of this country in the "Safety First" movement. It must not be forgotten that America had a lot of leeway to make up, and that was what gave the impression that they were going ahead so fast.

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* The Police Factories Miscellaneous Provisions Act.

He hoped the Illuminating Engineering Society would inaugurate a campaign against the too liberal use of lighting, as well as against the lack of it. Anyone who travelled in America would be impressed by the extraordinary progress of architecture in that country, and the beautiful proportions of many of the buildings; but one often found that the factory or business house or store was entirely spoilt by a hideous erection on the top, with reflectors and so on, to cast a brilliant light on the name of the proprietor.

MR. J. W. BEAUCHAMP said he had been very much interested in Mr. Gaster's paper, and he hoped some means would be found for giving it wide publicity. As one who frequently had, in the past, to bargain with industrial people about light in factories, he had been specially interested to hear how small was the relative cost of lighting —even good lighting—to other things, such as labour, material, etc. He was sure that was not generally realised. The psychological influence of lighting was a point worthy of attention. There was no doubt that the illumination of a factory had a considerable effect on the people who worked there. Diffused lighting had a lot in its favour, but if carried to excess it exercised a gloomy and chilling effect; on the other hand, a moderate degree of concentration had the effect of concentrating a man's attention on his work. It might be very uncomfortable to work in a bright spot in a dark room, but it was equally displeasing and depressing to work in a very much diffused light. He had felt—and he thought most workers with fine tools shared the feeling—that a decided spot light helped one to concentrate on one's work and prevented distraction. It was a small point, but he hoped it was one which the Society would consider.

MR. C. PIZEY considered the paper well worthy of careful consideration. Personally, he was more interested in domestic than industrial lighting, but he fully appreciated what Mr. Gaster had said as to the great value of efficient lighting in factories. There could be little doubt that, given efficient lighting, the output of the workers was considerably increased, and the quality of it improved.

MR. W. WYLD said he had listened to the paper with intense interest. He was sure that if Mr. Gaster's remarks were given wide publicity through the medium of the press they would do an immense amount of good. At the present time a number of factories were altogether out of date so far as their lighting was concerned, and their output was thereby diminished. He would like to hear more about the apparatus used in the lighting tests which Mr. Gaster had mentioned. It seemed to be a comparatively simple arrangement, very different from the cumbrous and often inaccurate instrument formerly employed. He thought the apparatus described should be taken up by illuminating engineers, and the scientific data thereby obtained form the basis on which all factories should be lighted in the future.

MR. J. S. DOW said Mr. Gaster had referred to the curious anomaly that so very often this country had originated something really fine and then allowed it to drop, after which it was taken up and developed by other countries. Legislation on factory lighting was a case in point. Of course the war had delayed matters, but now that impediment had been removed he hoped more progress would be made. He had been associated with Mr. Gaster for a long time, and thus had many opportunities of seeing that the authorities really did pay a great deal more attention to lighting than the mere fact that there was no reference to illumination in the Factory Acts would suggest. Deliberation had preceded action, and the Home Office Report of 1915 came just at the right moment, when people generally accepted the fact that good lighting was necessary in factories and when manufacturers had studied lighting sufficiently to be able to carry out what was expected of them. One thing he would like to see proceeded with was the formation of an industrial museum. Such a museum had been contemplated before the war, but the scheme had necessarily remained in abeyance until now. He believed it had been the intention to have a special section in that museum devoted to lighting. He thought the American States had gone a little too far in their Codes in the direction of elaborating details. What was needed was some broad general principles. With regard to lighting it could be said broadly that certain orders of illumination were required for different processes; and having said that, it might be left to the individual industries and the lighting experts to confer together and settle the details, and the Home Office authorities could act as guides and supplement the general recommendations by specific hints which would really be a help to manufacturers. That would be what Mr. Gaster wanted, legislation by consent. The real point was to get the necessary information disseminated so that everybody knew what to do. Another reason in favour of having an elastic framework was that they did not know yet what was the economical limit to which illumination could be carried. Some experiments in production made in the United States suggested that in course of time it might be found that much higher illumination than was demanded at present would be economically desirable. Their aim should be, therefore, to get the principles of good lighting clearly enunciated in their legislation, and then to have something in the nature of a permanent inquiry, conveniently carried on under the existing Departmental Committee on Lighting in Factories and Workshops, which could conduct investigations and collect data showing the kind of lighting required in various industries, and the exact relation it had to health, safety and efficiency.

Mr. R. Claude Bussell said that if ever an industrial museum such as had been suggested by Mr. Dow was formed, he hoped there would be a chamber of horrors attached to it—a museum of bad taste. It was unfortunate that the standard of lighting, adopted by the uninitiated was not what it would do but what it was, and the remark commonly made on a new lamp of any sort was, "A fine light." If anyone wanted to be really tortured, he should go down the Walworth Road on the top of a 'bus one winter's evening. From end to end it was a striking example of how not to do it. The amount of money thrown away there alone in lighting must be enormous.

Mr. Leon Gaster, in reply, expressed his appreciation of the Chairman's remarks. In the course of the many lectures and discussions before the Royal Society of Arts which he had attended he had always been impressed by the fact that the Society went direct to the source of the latest information, in approaching each subject. It had been a pleasure to him to convey in his paper some of the information collected through the experience of the Illuminating Engineering Society on industrial lighting. He was glad to see that the various speakers agreed as to the desirability of "Government by Consent." Experience showed that it was undesirable to attempt to bestow benefits by force, but in the case of industrial lighting people now recognised the need for regulations and would willingly accept them. The Report of. the Home Office Departmental Committee had already determined the amount of illumination desirable in the interests of safety and general convenience, and had arrived at the figure of 0·25 foot-candle, as a result of actual tests in a large number of factories, which ensured that the demand in this respect could readily be met. The instrument used in these experiments, about which several speakers had inquired, was the Holophane Lumeter, of which he had an example on exhibition. He was very glad indeed to hear from Dr. Legge, who had done so much to promote improvements in industrial illumination, that there was a prospect of a general statutory requirement of adequate lighting being inserted in the Factory Acts shortly. He agreed that the requirements should at present be of a general character. The requirements as regards the working illumination for various processes could be readily settled by conference between experts and representatives of the industries concerned. He had not meant to imply that the United States was in all respects in advance of this country, but rather that they had been in a fortunate position to profit by the experience of this country during the war. The methods in the United States were different. When he visited that country about six years ago the *New York Times* published a full page interview dealing with his suggestions regarding illumination, and industrial lighting in particular. At that time it was feared that owing to the independent legislation of the various States it would be difficult to carry through general requirements on industrial lighting. But in the ensuing six years six States had actually adopted legislation. When, however, this country adopted a statutory requirement of adequate lighting in factories, they would have the advantage that it applied to the whole country. As he had indicated in his paper there was a good prospect that industrial lighting would ultimately be dealt with on an international basis, and this country should take a leading part in action of this kind. In conclusion, Mr. Gaster thanked the other speakers for their kind references to the paper, and said that he was glad to observe that the views he had expressed met with general agreement.

The Chairman said the meeting largely appeared to agree with what Mr. Gaster had said; there had been very little criticism. Mr. Gaster's was one of those excellent practical papers, written by men who knew their subject thoroughly, which the Society was always anxious to receive. He proposed a very hearty vote of thanks to the author.

The vote of thanks was carried unanimously.

THE CERAMIC INDUSTRIES OF THE NETHERLANDS.

The ceramic industries of the Netherlands have been celebrated from the earliest times. In regard to raw material, no country is better fitted for the manufacture of earthenware. The valleys of the Rhine, Waal, Maas, Yssel, and their tributaries are lined with a stiff river clay, as "fat" as the potter can desire. The Maritime Provinces are covered with a layer of sea clay, deposited in ages past when the sea broke through the line of protecting sand dunes and flooded the low-lying land. The native clays cover a wide range of colours and properties suitable for pottery, brick, or tile making.

For clays, earths, mineral colours, and glazes that are lacking in the geological make-up of the country, the Netherlands, in ordinary times, have access to neighbouring countries which can supply them.

Pure kaolin is one of the earths lacking in the Netherlands and has to be imported, and the making of fine porcelain and china is handicapped for that reason.

The ceramic industries are well distributed over the Netherlands. Not merely the historic centres of the industry, but a number of towns less well-known are contributing to the country's output of fine and coarse earthenware. In 1918 there were sixty-nine establishments manufacturing earthenware and tiles. Of these nine were situated at Gouda, six at Utrecht, three at Delft, three at Arnhem, three at Bergen op Zoom, three at Maastricht, three at Nijmegen, two at Deventer,

two at Hazerswoude, two at Jutfaas, two at Leiderdorp, and two at Sneek.

The largest of these factories, situated at Maastricht, employed 2,000 workers. The combined number of employees in six other establishments was 755. Two of the principal factories, each employing 200 workers, used 90 horse-power each.

The most celebrated product of the Dutch ceramic industry is the blue-and-white delftware. Its origin goes back to the beginning of the seventeenth century and resulted from an effort to imitate the Chinese blue-and-white jars and plates which were just being introduced from the Orient. The industry flourished in the seventeenth century and well into the eighteenth. It extended from its original home at Delft to Arnhem, Amsterdam, Haarlem, The Hague, Nieuwer-Amstel, Oud-Loosdrecht, and Weesp. Delft alone boasted thirty earthenware factories in the palmy days of the industry. Vases, plates, tiles, and ornaments of all descriptions were produced in profusion and went to adorn the houses of the period. From the original blue-and-white the makers launched into a variety of colours and designs, finding their inspiration for the latter in the familiar scenes of Dutch daily life.

In the second half of the eighteenth century the market for delft declined, owing to the flooding of the European market with cheaper porcelains imported directly from the Orient, to the successful imitation of delftware by the French factories, and to the success of the English Wedgwood ware. The Dutch factories were gradually compelled to close down until, after 1850, only one of the establishments which had made the fame of delft survived. This factory, with the aid of the last of the tile painters who knew the old art, revived the industry in 1876. The success of their efforts to make blue-and-white delftware along the old designs has established the industry on a firm basis.

The characteristic shapes and designs of delftware are well-known even to the merest amateur collector of fine earthenware. The background is a glazed white, on which floral designs, birds, arabesques, and scenes of Dutch life are painted in a shade of blue known the world over by the name of delft blue. Less well known, but no less artistic, is the "coloured" delft, in which reds and greens are blended in harmonious designs. The remarkable feature of the older delft is the skilful way in which the impurities of the native clays have been concealed by a well-applied, white-lead glaze with a soft lustre. The modern makers of delftware have at their disposal the finest kaolins that can be imported. Modern delftware is made up into plates, dishes, tea sets, table services, vases, art tiles, tile portraits, bric-a-brac, and a host of ornamental objects.

The study of the characteristic makers' marks and designs of the antique delft is a science in itself. "Genuine" delft of the present day is considered to be the output of a single factory at Delft, the only present survivor of the thirty factories that flourished in that city in the palmy days of the industry. This factory has the credit of reviving an industry that was threatened with extinction. "Imitation" delft is made in the familiar blue-and-white designs at Gouda.

The Dutch factories, make, moreover, a considerable quantity and variety of the ordinary grades of chinaware for table services and other domestic use. Some of these follow the delft patterns; others imitate the Japanese and Chinese designs, while still others do not differ greatly from the styles sold in the United States.

Gouda earthenware has won for itself a reputation for its characteristic designs and colours. The principal material is a grey clay of domestic origin. Upon this are painted designs in brilliant reds, blues, yellows, greens and whites, frequently of a floral motif. It is principally made up into vases, jardinieres, platters, trays, humidors, ash trays, and ornamental plates. It is found in both the glazed and unglazed finish.

A pottery similar in colour effects to the Gouda, but more conventional in design, is made at Nordwijk. Katwijk earthenware has a bright yellow ground. At Utrecht the St. Lucas faience has become celebrated for its brilliant metallic glaze, which causes it to gleam like porcelain in certain lights, and in others to glow like gold or bronze.

At Makkum, in Friesland, the celebrated old "Makkum blue" ware is being successfully imitated. De Lemmer, in Friesland, has given its name to a type of uncoloured, glazed pottery of blue-and-yellow clay, with hand-carved, geometrical patterns.

A speciality of the potteries of Gouda is the manufacture of clay pipes. This industry dates back to 1637, and in its most prosperous days in the eighteenth century no less than 16,000 persons were employed in it. To-day there are seven factories at Gouda producing these pipes, and one at Weert. The largest of these at Gouda employs 150 workers and uses twenty horse-power.

Tile making is a branch of the ceramic industry in which the Hollanders have been especially successful. Tiles of all sorts are made, from roofing to flooring tiles, including tiles for purely decorative purposes. The latter are made in a wide range of colours and patterns, and are extensively used for decorating the outsides and insides of buildings. Entire fronts of buildings are decorated with pleasing patterns in tile work; for interior use they are found not merely in vestibules and around hearths, but covering entire walls. The newer office and factory buildings are extensively finished with attractive designs in tile.

In picture tiles the Dutch are excelled by none. The favourite designs are portraits, Dutch scenes, or remarkable reproductions of celebrated paintings in sepia or delft blue. Some of these are of single, large tiles; more often they are made up of individual tiles of about five inches square, with the sections of the design so merged that the lines

of division are scarcely noticeable. These are employed not only as house decorations built in the walls, but are frequently framed and hung up as pictures.

Floor and roofing tiles are generally produced in establishments making art pottery and porcelains. Roof and floor tiles were made by forty-six establishments in 1918, many of which are identical with the factories mentioned elsewhere as making earthenware and faïence. Koudekerk in Zeeland, led in the number of tile-making establishments with four, Maastricht followed with three, Utrecht with three, Woerden three, Alphen aan den Rijn three, Liederdorp, South Holland, two, Oudshoorn, South Holland, two, and Zuilen in Utrecht with two.

Roofing tiles of various materials are made in sixty-seven factories. Six of these establishments are in the appropriately named town of Tegelen, in Limburg, four are in Swalmen, Limburg, three in Winterswijk, in Gelderland, three in Reuver, Limburg, two in Leeuwarden, two in Utrecht, two in Woensdrecht, North Brabant, two in Alphen, South Holland, two in Belfield, Limburg, and two in Echt, Limburg. Many of the roofing-tile factories are also brickmaking establishments.

The characteristic roofing material in use in the Netherlands is the flat tile of red clay, with one edge bent up and the other bent down, forming an S-shaped shingle, whose edges interlock to exclude the rain. Other similar tiles are made of blue, or smoked, black clay. At Oegstgeest and Makkum the flat Frisian tiles are made.

A "fat" river clay of domestic origin furnishes the raw material for these tiles, which are subject nowadays to strong competition from similarly shaped tiles of cement, asbestos cement, and bent glass.

GENERAL NOTES.

The Agricultural Resources of Cyprus.—The first part of an interesting article on the "Agriculture of Cyprus," by Mr. W. Bovan, Director of Agriculture in the island, has recently appeared in the Bulletin of the Imperial Institute. The subjects dealt with include live stock, dairy produce, cereals, fruits, nuts, and vegetables. The Messaoria plain is the great corn-growing area, and in ancient times the island produced sufficient wheat to supply all the needs of its population, which then numbered over a million, the annual production amounting to about 10,000,000 bushels. At the present time, with a population of a little over a quarter of a million, only about 2,000,000 bushels of wheat are being produced, but the yield could be greatly increased by better methods of husbandry, by the use of improved implements for cultivating and reaping, and by the use of threshing machines. The methods practised have changed little for ages. The old wooden plough is still used, whilst the threshing-floors are practically identical with those of Biblical times, consisting merely of a levelled piece of ground, sometimes paved with flag-stones. A stout board, studded on the undersides with sharp flint stones (the tribulum of Virgil), is drawn over the spread-out sheaves by mules, donkeys, or oxen. Large quantities of barley are grown, the production in 1918 amounting to over 3,000,000 bushels. Most of this is used locally for feeding cattle, but some is exported to England for malting purposes. The cultivation of the grape-vine and the making of wines are important industries, and the celebrated Commandaria wine, which acquired great fame in the time of the Knights Templars, is still being produced and exported in limited quantities.

The Anhinga Fibre Industry.—The plant known as anhinga is a native of the State of Para, Brazil, and it is declared that this State alone is capable of producing 100,000 tons annually for export. The anhinga constitutes the raw material from which cellulose for the manufacture of linen paper is obtained. The fibres may also be transformed by a chemical process into an artificial cotton fibre. The fact that this fibre does not decay gives it an advantage over that obtained from analogous plants. The anhinga grows along the banks of all the rivers of Para, which have a slow current, permitting a soft bed of mud for their roots. In 1908 the Commercial Association of Para received a letter from a paper factory as to the possibilities of obtaining this fibre in large quantities, but at the time the Association was unable to find anyone to exploit the industry, because of the large and easily acquired profits afforded by the rubber industry. However, according to a statement published by the United States Department of Commerce, experiments were made in 1918 with excellent results, and those interested in the new industry have recommended that abandoned sugar-mills be fitted up for the treatment of the fibre. A mill already in operation is producing 600 kilos daily. The price of the fibre at Para is 300 to 350 reis per kilo. It is stated that the head of the Para State Chemical Laboratory has discovered a new process for dissolving the fibres, transforming them into very fine, white fibres, like cotton fibre of prime quality. Moreover, their structure is superior to that of the cotton fibre, since the lines are straight and parallel.

MEETINGS OF THE SOCIETY.

Ordinary Meetings.

Wednesday afternoon, at 4.30 p.m.:—

May 19.—John Somerville Highfield, M.Inst.C.E., M.I.E.E., W. R. Ormandy, D.Sc., and D. Northall-Laurie, F.I.C., "The Commercial Application of Electrical Osmosis."

ALAN A. CAMPBELL SWINTON, F.R.S., will preside.

The phenomena known as Electrical Endosmose and Cataphoresis, whereby matter in a very finely divided state is capable of being influenced by an electrical potential, has many applications in commercial processes.

The paper will deal more especially with the application of Electrical Osmosis as applied to the purification of clays, and will be illustrated by experiments and lantern slides.

INDIAN SECTION.

Thursday afternoon, at 4.30 p.m.:—

MAY 20.—BRIGADIER-GENERAL LORD MONTAGU OF BEAULIEU, K.C.I.E., C.S.I., "Roads and Transport in India." LIEUT.-GENERAL SIR HERBERT V. COX, K.C.B., K.C.M.G., C.S.I., Military Secretary, India Office, will preside.

Monday afternoon, at 4.30 p.m.:—

MAY 31.—ALBERT HOWARD, C.I.E., M.A., A.R.C.S., F.L.S., Imperial Economic Botanist to the Government of India, "The Improvement of Crop Production in India." SIR ROBERT W. CARLYLE, K.C.S.I., C.I.E., will preside.

Friday afternoon, at 4.30 p.m.:—

JUNE 18.—SIR VALENTINE CHIROL, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

INDIAN AND COLONIAL SECTIONS.
(Joint Meetings.)

Friday afternoons, at 4.30 p.m.:—

MAY 28.—PROFESSOR WILLIAM A. BONE, D.Sc., Ph.D., F.R.S., "Lignite."

JUNE 4.—PROFESSOR SIR JOHN CADMAN, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E., "The Oil Resources of the British Empire."

CANTOR LECTURES.

Monday evenings, at 8 p.m.:—

ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837." Three Lectures.

Syllabus.

LECTURE III.—MAY 17.—The third lecture is devoted to Sir John Soane, and traces his relations to the movement begun by Robert Adam and to the Greek and Mediæval revivals. Soane's ideas on architecture and decoration are discussed in relation to his more important works. In conclusion, it is pointed out that three-quarters of a century is covered by the work of Robert Adam and John Soane.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 17...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Mr. A. T. Bolton, "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758-1837." (Lecture III.)

Victoria Institute, Central Hall, Westminster, S.W. 4.30 p.m. The Right Rev. Bishop G. Forrest Browne, "Monumental Art in Early England, Caledonia, and Ireland."

Geographical Society, 135, New Bond-street, W., 8.30 p.m. Captain F. K. Ward, "The Valleys of Kham."

East India Association, 7A, Tothill-street, Westminster, S.W., 3.45 p.m. Mr. S. G. Roberts, "Tamil Proverbs: a Key to the Language and to the Mind of the People."

TUESDAY, MAY 18...Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5.30 p.m. Mr. R. Stirling, "Air Lift System of Pumping Oil Wells."

Royal Institution, Albemarle-street, W., 3 p.m. Professor A. Keith, "British Ethnology—The Invaders of England." (Lecture IV.)

Anthropological Institute, 50, Great Russell-street, W.C., 8.15 p.m. Sir Henry Howarth, "Buddhism in the Pacific."

Colonial Institute, Central Hall, Westminster, S.W., 3.30 p.m. Mr. L. W. G. Malcolm, "The Cameroons."

WEDNESDAY, MAY 19...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Messrs. J. S. Highfield, Dr. W. R. Ormandy, and D. Northall-Laurie, "The Commercial Application of Electrical Osmosis."

Meteorological Society, 70, Victoria-street, S.W., 5 p.m. 1. Dr. G. Taylor, "Agricultural Climatology of Australia." 2. Messrs. J. E. Clark and H. B. Adames, "Report on the Phenological Observations for 1919."

Geological Society, Burlington House, W., 5.30 p.m.

THURSDAY, MAY 20...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Brigadier-General Lord Montagu of Beaulieu, "Roads and Transport in India."

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Chemical Society, Burlington House, W., 8 p.m.

Royal Institution, Albemarle-street, W., 3 p.m. Mr. A. P. Graves, "Welsh and Irish Folk Song." (Lecture II.)

Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 5.30 p.m. Annual General Meeting.

Numismatic Society, 22, Russell-square, W.C., 6 p.m.

University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 6 p.m. Dr. S. Ahmad Khan, "The Development of Modern Educational Institutions in India." (Lecture III.)

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, W., 5.30 p.m. 1. Mr. G. Rigg, "Roasting and Lead-Smelting Practice at the Port Pirie (S.A.) Plant of the Broken Hill Associated Smelters Proprietary, Ltd." 2. Captain H. Tatham, "Tunnelling in the Sand Dunes of the Belgian Coast."

FRIDAY, MAY 21...Royal Institution, Albemarle-street, W., 9 p.m. Professor J. A. Fleming, "The Thermionic Valve in Wireless Telegraphy and Telephony."

Philological Society, University College, W.C., 5.30 p.m. Mr. C. T. Onions, Dictionary Evening.

SATURDAY, MAY 22...Royal Institution, Albemarle-street, W., 3 p.m. Mr. F. Harrison, "The Reaction and the Critics of the Positivist School of Thought."

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FRIDAY, MAY 21, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

POSTPONED CANTOR LECTURE.

The third lecture of the course on "Aluminium and its Alloys," by Dr. Walter Rosenhain, F.R.S., Superintendent of the Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, which was postponed from April 26th in consequence of the sudden illness of the lecturer, will be delivered on Monday, June 7th, at 8 p.m.

POSTPONEMENT OF THE PAPER ON "LIGNITE."

Professor William A. Bone, D.Sc., Ph.D., F.R.S., has been unavoidably compelled to postpone until next session the reading of his paper on "Lignite," which had been announced for Friday, the 28th inst.

CANTOR LECTURE.

On Monday evening, May 17th, Mr. Arthur Thomas Bolton, F.R.I.B.A., F.S.A., Curator, Soane Museum, delivered the third and final lecture of his course on "The Decoration and Architecture of Robert Adam and Sir John Soane, 1758–1837."

On the motion of the Chairman, seconded by Mr. F. H. Hebblethwaite, a cordial vote of thanks was accorded to Mr. Bolton for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

INDIAN SECTION.

Thursday afternoon, May 20th; Lieut.-General Sir Herbert V. Cox, K.C.B., K.C.M.G., C.S.I., Military Secretary, India Office, in the chair. A paper on "Roads and Motor Transport in India" was read by Brigadier-General Lord Montagu of Beaulieu, K.C.I.E., C.S.I.

The paper and discussion will be published in a subsequent number of the *Journal.*

TWENTY-FIRST ORDINARY MEETING.

Wednesday, May 19th; Mr. Alan A. Campbell Swinton, F.R.S., Vice-President of the Society, in the chair.

The following candidates were proposed for election as Fellows of the Society:—

Baines, Hubert, C.B.E., London.
Hakes, James A., Sunbury-on-Thames.
Hartigan, Lieut.-Colonel Marcus Michael, C.M.G., D.S.O., Ashford, Middlesex.
Hosken, Richard, Assoc.M.Inst.C.E., M.I.M.E., London.
Osborne, F. B., London.
Rutherford, Henry, London.
Sarasasna, Lieut.-Colonel Bra, Bangkok, Siam.
Smith, George, London.
Stuart, John Matthew Blackwood, B.A., Enniskillen, Ireland.
Tarrant, Ernest Frederick, London.

The following candidates were balloted for and duly elected Fellows of the Society:—

Bixby, William Keeney, M.A., LL.D., St. Louis, Missouri, U.S.A.
Bowden, John, Chorlton-cum-Hardy, Manchester.
Christie, Edward William, London.
Cleveland-Stevens, Edward Carnegie, M.A., D.Sc. (Econ.), London.
Cravath, Paul D., A.M., LL.B., New York City, U.S.A.
Davies, Thomas Bertram, Durban, Natal, South Africa.
Grieve, Norman William, London.
Gross, Alexander, F.R.G.S., London.
Kerr, Henry Farquharson, New York City, U.S.A.
Norrington, George Frederick, Wilmslow, Cheshire.
Perry, Mrs. Thos. Sergeant, Boston, Mass., U.S.A.

Reed, Harry E., Swansea.
Richards, Captain James Charles, Assoc.Inst.N.A., Bombay, India.
Summers, Albert Victor, Cheadle Hulme, Cheshire.
Thomas, David Idwal, M.Inst.M.E., Porth, Wales.

A paper was read on "The Commercial Application of Electrical Osmosis" by Messrs. JOHN SOMERVILLE HIGHFIELD, M.Inst.C.E., M.I.E.E., W. R. ORMANDY, D.Sc., and D. NORTHALL-LAURIE, F.I.C.

The paper and discussion will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, April 15th, 1920; THE RIGHT HON. EDWIN S. MONTAGU, M.P., Secretary of State for India, in the chair.

THE CHAIRMAN, in opening the meeting, said he did not propose to commit the impertinence of introducing Sir George Buchanan, because his reputation was established amongst all those interested in engineering works in India. In 1914 Sir George read to the Society by deputy a paper on "The Port and City of Rangoon," and Lord Inchcape, who presided, expressed the opinion that Sir George had saved that port by the great work he had carried out. It was true to say that his work there was remarkable from the point of view of those interested in Indian finance, in that he did everything he wished to do inside his estimate—a very notable performance. He felt sure that after his work in India and in Mesopotamia Sir George could rely upon an interested audience with a hungry appetite for what he was going to say.

The paper read was—

THE PORTS OF INDIA: THEIR ADMINISTRATION AND DEVELOPMENT.

By SIR GEORGE BUCHANAN, K.C.I.E.

There is so much to be said on the subject that I have chosen for my paper, that it will be difficult adequately to deal with the matter and yet keep within the required limits of space and time.

For many years I have been an earnest student of port affairs, my studies not having been confined to Indian ports, and I came to the conclusion some years ago that unless there was an improvement in the existing method of administering and developing ports in India, they would be unable to keep pace with the requirements of an ever-increasing trade.

My reason for this view is that the immense importance of terminal facilities has not been sufficiently recognised in India, and ports are usually coupled with municipalities and district councils and looked upon as purely local affairs, regardless of the fact that whilst the evil a badly managed municipality does is practically confined to itself, a badly administered and developed port can cripple a whole province or even provinces.

The port of Karachi, for instance, is more the port of the Punjab than it is of Sind, and the port of Calcutta serves half the provinces of India.

It seems hardly credible that India, with a coast-line of over 4,500 miles, an area of over 1,800,000 square miles, a population of 350,000,000, and a trade the total value of which before the war exceeded £300,000,000 sterling, possesses only six ports with any pretensions to the name.

The entire west coast of India is served by Karachi and Bombay, the east coast by Madras, Calcutta, and Chittagong, and Burma by Rangoon, whilst as indicating the physical aspect of the country, Bombay, Karachi, and Madras are seaports, and Calcutta, Chittagong, and Rangoon river-ports.

There are a certain number of minor ports—viz., Porbandar and Veraval between Karachi and Bombay; the Portuguese port of Marmagao, south of Bombay; Mangalore, Calicut, Cochin, and Quilon on the Malabar Coast between Bombay and Cape Comorin; Tuticorin, and Cocanada, with Vizagapatam in course of execution, on the east coast; and Akyab, Bassein, Moulmein, Tavoy, and Mergui on the Burma coast. All the minor ports are, however, undeveloped, and principally used for the coasting trade.

The year before the war, the six major ports had an aggregate revenue of 368 lakhs of rupees, an expenditure of 327½ lakhs, and a capital debt of 3,000 lakhs; 16,150,000 tons of shipping entered the ports during the year, and the aggregate value of trade was 51,289 lakhs of rupees, whilst taken proportionately Bombay and Calcutta headed the list; then came Karachi and Rangoon, followed a long way after by Madras and Chittagong.

I give these figures to show by their magnitude that the ports of India are worthy of development and encouragement.

In order to form some idea of the problems dealt with under the heads Port Administration and Development, I will briefly analyse the

requirements of a modern port, after which I will describe and discuss the leading characteristics of the major ports of India and give my views on port administration and port development.

Port Requirements.

The object of a Port Administration is to benefit the community at large and the trade of the country, bearing in mind that business follows port facilities.

The problem of port development necessitates as a preliminary step a study of actual local conditions at the port itself, but there are certain facilities and equipments that are essential for any first-class port. These primary requirements are: (1) Facility for prompt despatch of steamers, (2) ample storage accommodation for goods, (3) adequate transport facilities behind the port, the first of these being largely contingent on the extent of the second and third. The growth in the size of ships has been very great in the last fifty years, and the necessity for adequate port accommodation has increased proportionately. The greater the size of vessels, the more economically can they be run, owing to the fact that the consumption of fuel is *pro rata* less and the voyages required fewer, and it has been shown that if the draught be increased proportionately to the increase in other dimensions, the cargo can be carried at a steadily decreasing cost as the size increases.

In days gone by, when ships were comparatively inexpensive, they were built to suit the ports which were considered to be costly. The situation is now reversed, and if the authorities at a port wish to secure or hold the trade, they must be prepared to march with the times and adapt their ports to the ships. And the ports that are most efficient are those that have kept their facilities ahead of actual requirements. Despatch, despatch, and again despatch is what the port authority has to look to, and the shipowner with a valuable vessel in which an enormous sum is capitalised, and with constant large current expenses, naturally prefers a port which gives good despatch. From the port authority's point of view, to make a port popular with shipowners means to make it a port to which it is profitable to come, and a port to which a low freight will be accepted.

What constitutes adequate facilities for the prompt despatch of steamers and storage of goods, is a question that every port must answer for itself, but, as a rule, it resolves itself into the following:—

1. A deep, well-buoyed and well-lighted channel, extending from the sea to the entrance to docks or wharves.
2. Sufficient deep-water wharf accommodation, either inside docks or alongside a river or harbour front.
3. An abundance of cranes or conveyors and ample shed and warehouse room.
4. Ample railway and road connections to the interior, and where there is inland navigation, facilities for transhipment to river steamers, when and where required.

The rate of discharge from the ship is controlled by the ability to give clearance on shore, and the capacity of ships has now become so great that the accommodation in the sheds and the ability of consignees to take delivery are taxed to their utmost, in endeavouring to keep pace with the actual discharging operations.

The above is a summary of what may be called the working requirements of a port, and of equal importance are the financial requirements; the main considerations governing the financial working of a port being: (*a*) that the expenditure should not exceed the revenue, *i.e.*, that it should never be necessary to borrow from capital to pay revenue charges; (*b*) that capital charges should be so adjusted as not to burden unduly either the present generation or posterity; (*c*) that rates, dues, and charges should be uncomplicated, easily collected and levied so that there is an even distribution of taxation, no one individual or portion of the community being taxed to the benefit of another which pays nothing; (*d*) that port dues, rates, and charges should be liable to as few alterations as possible.

The ratio between tonnage dues on vessels and rates on goods has to be considered, and above all it must be remembered that there is a limit to the capacity for payment by both shipowners and merchants.

From the above it will be seen that the control of a large modern port is no sinecure, and requires special knowledge and continual study on the part of the members of the port authority.

Description of the Ports.

Bombay.—Bombay is the premier port in India, and has been fortunate in having had for generations a definite policy, and engineers in charge of the port works who had been specially trained as harbour and dock engineers in the United Kingdom. The Port Trust was created in 1873, when the property of the Elphinstone Reclamation Company was purchased by Government for the sum of 186 lakhs of rupees, and their engineer, Thomas Ormiston,

was the first engineer to the Port Trust. The Prince's Dock, begun in 1875 and completed in 1880, has a basin accommodation of 30 acres, and a depth on the sill below H.W.O.S.T. of 28·25 ft., and below H.W.O.N.T. of 25 ft. In 1885 the construction of the Victoria Dock was undertaken, and completed in 1888, with a basin of 25 acres and a depth on the sill two feet lower than the Prince's Dock.

In 1905, the Alexandra Dock was begun, and it was opened by the Viceroy on March 21st, 1914. This dock has an area of 49½ acres, with a depth on the sill of 37·25 ft. at H.W.O.S.T. and 34 ft. at H.W.O.N.T., or 9 ft. lower than the Prince's Dock.

The Prince's and Victoria Docks can accommodate 27 vessels of lengths ranging from 300 ft. to 500 ft.; the Alexandra Dock provides for an additional 17 vessels of 500 ft. to 520 ft., and another berth for a vessel of 425 ft. has been provided outside the dock for mail steamers. The docks are well equipped with sheds, warehouses, cranes, etc., and in recent years 580 acres of land have been reclaimed on the foreshore north of the docks, which is to be utilised for the cotton, grain and manganese ore trade. The port of Bombay is served by the Great India Peninsula and Bombay Baroda and Central India Railways, through a Port Trust railway, which traverses the dock estate. Financially, Bombay port is in a strong position, its trade is assured, and the port revenue is derived from so many sources that a failure in any one branch of the trade would not materially affect the financial situation, especially with the large revenue reserve fund. The whole of the foreshore is owned by the port, and a noteworthy feature in the accounts is the large amount received from ground rents.

The Port Trustees are now discussing further dock extensions either in front of the Alexandra Dock or up the harbour in the direction of Trombay. To add to the present traffic congestion by building another dock in the vicinity of the present docks would, I consider, be a great mistake, and obviously the port must expand in the Trombay direction, but whether it is necessary or even desirable to build a dock is matter for consideration.

The Trustees have got so into the habit of building docks that they are, perhaps naturally, averse to consider alternatives, but the site appears on the face of it to be particularly favourable to the construction of a large deep-water wharf. Modern dredgers could without difficulty cut a deep channel right up the harbour, and by using the material dredged for reclamation purposes, a magnificent export yard with a deep-water wharf, capable of great expansion, could be constructed at a considerably less cost than would be necessary for a dock, and in these days of dear money a saving on capital expenditure is not to be neglected.

It is also of the first importance to deepen the water in the main entrance channel to Bombay Port, and at the anchorage, and all the material dredged could be used for reclamation purposes, either for the port, or the extension and improvement of the town. At present, there is only 22 ft. to 26 ft. below the mean of lowest spring tides within a mile of the docks, and a depth of 32 ft. in the entrance channel at high water of neap tides, the result being that steamers of ordinary draught are delayed for want of water, a case in point being a recent mail steamer from Bombay to London, drawing only 27½ ft., which had to postpone her scheduled time of sailing by several hours because there was insufficient water in the main channel. The time lost at Bombay was the direct cause of several more hours being lost at Suez and Port Said, the result being that mails and passengers arrived in London twenty-four hours late.

Such an incident in a port which considers itself in the first rank, is, to say the least of it, most unsatisfactory. The Port of Bombay requires very careful handling in the near future, a great deal of money will have to be spent, and it behoves the authorities to see that a correct policy of expansion is adopted.

Karachi.—Karachi was occupied by the British in 1839, and at that time the port was a shallow, more or less land-locked lagoon. Up to the year 1873, the port was merely an anchorage, and all exports and imports by seagoing steamers had to be shipped and landed by means of country boats, but in 1870 was begun, and in 1873 finished, the Manora breakwater which protects the harbour entrance from the south-west monsoon, and the real development of the port may be said to have started from that date.

The Port Trust was created in 1886, at which time the port had accommodation for one seagoing steamer at a wharf, and eleven in the stream.

The port now possesses a continuous line of wharfage, 8,600 ft. in length, containing seventeen steamer berths, equipped with cranes. There is also a wharf 1,824 ft. in length for the country craft trade, and one 325 ft. long for

the coasting steamer trade, a bulk oil pier, a heavy lift pier, and an import yard separated from the wharves, to which imports are conveyed by rail, and a produce yard originally built for the use of merchants wishing to store grain prior to shipment.

There are also twenty moorings in the stream for ocean-going steamers.

The steamer wharves have a maximum depth of water alongside of 28 ft. at H.W.O.S.T., which it is proposed to increase to 34 ft., and there is a minimum depth in the approach channel of 32 ft. 6 ins. at H.W.O.N.T.

Communication with the interior is by the North-Western Railway, which traverses the Punjab in various directions and has lines running through Baluchistan to the frontiers of Afghanistan and Persia, and to the North-West Frontier Province.

The Jodhpur-Bikaner Railway, metre gauge, starts at Hyderabad and serves Rajputana, one branch going to Delhi; but for some obscure reason is not permitted to run into Karachi from Hyderabad. A broad-gauge line from Karachi to Jhansi, connecting with the Great India Peninsula to Cawnpore or Gwalior, and thence to Cawnpore, is clearly indicated, and will presumably be built in the near future.

The Port of Karachi depends for its prosperity almost entirely on the grain trade, and a failure in the monsoon or other disturbing factor at once causes a serious fall in the revenue.

The greatest total export in one year was 3,000,000 tons of wheat, barley, maize, gram, and a certain quantity of military stores in 1917-1918, and the greatest export of wheat was 1,380,000 tons in 1904-1905. Imports vary from 700,000 to 1,000,000 tons per annum, and on an average the total quantity of export and import may be taken at 2,500,000 tons to 3,000,000 tons per annum, from which the Port Trustees derive a revenue of approximately Rs. 1½ per ton.

The financial position is not particularly strong. The total revenue varies from 35 to 60 lakhs, and the Port Trustees consider 50 lakhs as a safe average to depend upon for the next ten years. The expenditure, except in an abnormal year, runs the revenue very close. The total debt is 257 lakhs, and the annual payment in interest and sinking fund 15½ lakhs; the revenue reserve is 36½ lakhs. New schemes are under consideration, estimated to cost 250 lakhs, which, at 8 per cent. for interest and sinking fund, will add another 20 lakhs to the revenue expenditure, an amount it will be obviously difficult to meet unless rates and dues are greatly increased or there is a very material increase in trade.

At present there are neither storage sheds for grain, nor grain elevators, and during the busy season some six thousand wagons of the North-Western Railway are confined to the railway district, owing to the difficulty in disposing promptly of their contents. One solution of the problem is the installation of grain elevators at the port and in the grain producing districts, in which case any great scheme of wharf extension might safely be postponed for the time being. The declared policy of the Port Trust is, however, to defer action in the matter of elevators until there is an actual practical demand from either the trade or the North-Western Railway.

The trade are at present quite satisfied with the existing state of affairs, and will continue using railway wagons as warehouses so long as they are available, but the railway is getting restive. A committee appointed by the Government of India in 1909 reported generally in favour of elevators, and there seems little doubt that with the certain expansion of the Karachi wheat export trade, elevators will ultimately be required, in order to bring Karachi into line with other grain-exporting ports.

It will be matter for regret if, when that time comes, the Port Trust are so committed to the old system and have spent so much on new wharves, that it will then be too late for the change.

The fact is that the whole future of Karachi requires the deepest consideration from the Imperial point of view, as it must some day be a very large port, and in addition to the yearly increasing export trade from Sind and the Punjab, Karachi is marked out as the chief Indian port for the trade with Mesopotamia and Persia. The people of Karachi are disposed to think that it might even now be a much greater port had it not been for jealousy on the part of Bombay, who looked upon Karachi as a dangerous rival. I doubt if such was ever the case to any material extent. The development of Karachi has been limited to the export requirements of the Punjab and Sind, and every extension of the irrigation systems in these provinces has led to increased exports, with demands for increased port accommodation. Karachi is 200 miles nearer to Aden than Bombay, and when a direct broad gauge line is constructed, Karachi will be a hundred miles nearer Delhi than Bombay, and therefore considers that she has a claim to

be the principal Indian port for mails and passengers from Europe. It must, however, be remembered that Karachi does not possess even the amenities of Bombay, and that consideration must be shown to mails and passengers to and from Bombay and Calcutta. I should therefore be surprised if Karachi could ever put up a strong enough case to supplant Bombay as a terminus for mails and passengers to and from Europe.

In my judgment Karachi is now at a most critical stage of its existence, requiring a wise, far-seeing policy on correct lines, as mistakes made to-day may have a tremendous effect upon the future.

Calcutta.—A writer, in 1853, observed: "Quays for the approach and use of shipping do not exist in Calcutta, neither are there any fixed landing stages, jetties or floating piers, partly perhaps owing to the questionable nature of riverside foundations, and the objection to attaching vessels to a quay wall during the bore, and also from a general absence of energy and enterprise in the local commercial interest, a general and indefinite idea being current that a comprehensive plan would some day be devised for securing greater advantages." Yet another writer, in 1882, said: "Up to the year 1868 the history of port improvements in the sense of appliances to facilitate the trade of the port is a history of projects and commissions of inquiry thereon. Much was proposed but nothing done." These writers of the past point a moral which it would not be difficult to apply at the present day, because it is an undoubted fact that Calcutta which, from its geographical situation at the head of the Gangetic Plain, should be one of the first ports in the world, has not kept up with the requirements of trade and navigation, and is one of the most backward ports in the East. In 1866, an Act was passed appointing the municipal authorities trustees for carrying out port improvement works, but by 1870, when the Port Trust was created, the total accommodation for seagoing vessels consisted of four small screw-pile jetties equipped with cranes and sheds; by 1882 there were eight jetties with a total length of wharf of 3,050 ft. and 230,000 square ft. of shed accommodation, and a definite impetus having been given, the question of constructing a wet dock was brought forward. For many years the building of a wet dock had been discussed in the abstract, and sites proposed at Tolly's Nullah, Diamond Harbour, Akra and Kidderpore. The latter site was finally adopted and the work begun in 1884. The first ship entered the dock on June 21st, 1892, but for a very considerable time thereafter the dock was empty, as the owners of vessels refused to use the dock, preferring the riverside jetties, and the consignees of imports refused to take delivery of their goods so far from their warehouses. By 1894 these prejudices had been to a certain extent overcome, as trade was increasing rapidly and great congestion obtained at the jetties. Ultimately the Port Trustees passed an order confining the use of the jetties to imports and the docks to exports. At the present time the Port Commissioners possess at the jetties nine berths for seagoing vessels with a frontage of 4,735 ft. and additional berths are under construction. Kidderpore Docks contain seventeen berths for general produce, and ten coal berths, and an additional berth for general produce has been recently constructed. The Commissioners also possess extensive sheds and warehouses for both exports and imports, a tea warehouse, inland vessels wharves and a petroleum wharf at Budge-Budge, and the Port Trust railway running between Cossipore and the Kidderpore docks on the left banks, and Howrah and Shalimar on the right bank, has an aggregate length of about sixteen miles.

Calcutta is served by the East Indian Railway, the Bengal-Nagpur Railway, the Eastern Bengal Railway, and by several lines of inland steamers. The East Indian and Bengal-Nagpur Railways have their termini at Howrah, on the opposite side of the river to Calcutta, but they get a connection to the docks by way of Naihati, where there is a bridge across the Hooghly and a connection with the Eastern Bengal Railway.

The correct policy in port development is always to have facilities a little in advance of necessities, and between 1895 and 1900 Calcutta was fairly up to date, but when the time came to make another push forward the Commissioners, as in earlier days, had resort to "Commissions of Inquiries."

In 1900–1 a Committee was appointed by Government to consider how the management of the port could be improved, especially with reference to economy and efficiency. The report therefore dealt largely with administrative details; the Committee did, however, propose various additional facilities for the import trade at the jetties, but expressed the opinion that no large capital expenditure was necessary in the near future at the docks, as their capacity was sufficient for all probable requirements and they were capable of gradual extension.

The Commissioners were thus lulled into a

feeling of security, and whilst the other large ports of India were busy with extensions and improvements Calcutta remained with folded hands, and was only awakened from its sleep by the clamour on the part of the public for facilities for meeting the rapidly increasing demands of trade, with the result that in 1913 another Committee was appointed by Government to deal comprehensively with the whole question of the development of the port of Calcutta.

The Committee issued its report on March 19th, 1914, and recommended approval to a very large dock extension scheme and to a number of minor improvements. Unfortunately the great war broke out in August, 1914, causing a postponement of all development schemes, and Calcutta is only now picking up the threads and making a fresh start. The Port Commissioners will have, however, to pay dearly for their lack of foresight, as the docks will cost twice the pre-war price, and at the same time the Commissioners will have to pay 50 per cent. more in interest on loans.

The trade of the port will no doubt improve rapidly now that the war is over, but the financial position leaves much to be desired. Even before the war the ordinary expenditure exceeded the ordinary revenue, and in 1918 there would have been a deficit of 18 lakhs of rupees, or, at Rs. 10 to the po nd, £180,000, had it not been for a war surtax amounting to 52 lakhs, or over half a million pounds. The revenue reserve is only 46 lakhs, compared with 90 lakhs at Bombay, whilst expenditure on interest and sinking fund, already amounting to 60 lakhs, will be vastly added to by the new dock scheme now in hand.

Apart from the provision of dock accommodation, Calcutta cannot in the future maintain its position as a great port unless measures are taken to improve the river.

The 1914 Committee recognised this basic fact, and in their report made the following observations :—

"(*a*) The prosperity of the port will be largely dependent on its capacity to receive the size and draught of vessels which can navigate the Suez Canal. This will involve a very considerable advance in the measure of improvement in the river approaches which has been obtained up to the present time.

"(*b*) The interests involved are of such magnitude, and in particular the capital sunk in the port will be so much increased by the dock extension that it would be unwise to rest satisfied with a more or less empirical system of dredging as the whole means of river improvement. On the contrary, the whole question should be again investigated and decided on at an early date by the port authorities.

"(*c*) The physical and economical aspects of that improvement are surrounded with problems of a very complex character, which can only be satisfactorily determined by such a consensus of the expert opinion available as will carry public confidence with it and enable the improvement to be undertaken with the greatest promise of success."

The Committee further pointed out that there were few modern ports of importance which had not found themselves compelled to face heavy expenditure in the improvement of access for vessels of deep draught, and they urged that the inquiry should not be postponed, as the problem was likely to be of increasing urgency.

In a paper of this description there is not space to go into details, but, broadly, the position is that for general everyday work the condition of the river limits the draught of vessels entering and leaving the port to 26 to 27 ft., but at spring tides it is possible to accommodate vessels up to 30 ft. The shoals are not only inconvenient but are a positive source of danger, and only last year a large steamer, laden with 6,200 tons of rice, grounded on a shoal, broke her back, and was abandoned a total loss.

There is no overwhelming difficulty in deepening and improving the river, nor is it even necessary to carry out at once, and at vast expense, an heroic scheme of training works, but the Port Commissioners appear to prefer a *laissez faire* policy, regardless of the fact that new docks and wharves are mere useless extravagances if the river is not deep enough to convey large vessels from and to the sea every day of the year.

The Port Commissioners as a body can hardly be held blameless for the backward state of the port and river, but the lack of initiative and inability to frame a definite policy or even to take competent advice is to a certain extent due to defects in administration.

In 1901, when the offices of vice-chairman and chief engineer were divided into two appointments, the vice-chairman became the chief executive officer of the Trust but still had as his senior an official chairman who was a Government official, and this led to "dual control," which has from time immemorial been fatal to efficiency. It may be argued that there are many ports at home and elsewhere with a general manager and an official chairman, but for various reasons this argument does not apply to India; and the fact remains that the successful ports of India owe their success largely to the

efforts of individuals who held the combined office of chairman and chief executive officer, and were able to frame a policy and carry it through. The failure to effect river improvement works can also be set down to faulty administration, inasmuch as the work is entrusted on the Hooghly to marine officers instead of to engineers. The illusion that because a dredger is a vessel it must necessarily be managed by a marine officer, and that because a marine officer navigates a vessel he must also be a student in problems of hydraulics, is one that hardly exists out of India, and it has led to many difficulties wherever this custom obtains. On rivers such as the Thames, Mersey, and Tyne, and on the American rivers, dredgers form part of the engineering equipment of the port, and are designed and controlled by the engineering department. All works connected with river improvement are also regarded as pre-eminently appertaining to the engineer, indeed, it is recognised that amongst the many matters which engage the attention of the engineer there are none more difficult than those which relate to the subject of rivers and stream control.

What is now urgently required at Calcutta is administrative reform, which can be best attained by the appointment of a whole-time chairman of great experience and ability (salary being of no importance if the right man can be obtained), assisted by a staff of experts in dock engineering, river engineering, and traffic management, and with efficient administration would come a healthier financial condition.

Rangoon.—As from 1901 to 1915, when I was sent to Mesopotamia, I held the offices of Chairman, Chief Executive Officer, and Chief Engineer of the Port of Rangoon, it is difficult for me either to praise or blame. I will, however, point out briefly the history of the port and state what, in my opinion, should be its policy in the future.

Between 80 and 90 per cent. of the whole of the trade of Burma passes through the port of Rangoon, which is situated on the Rangoon River, about thirty-nine miles from the sea. Up to the year 1879 the port was controlled by various bodies and individuals, but in that year a Port Trust was created, port limits defined, and the control and maintenance of the port vested in the Port Commissioners. The principal export is rice, and from earliest days this trade has been conducted in the stream, a convenient practice, as the millowners all possessed a river frontage to their mills, and the rice was conveyed in cargo boats to vessels moored in the river. This procedure has not been interfered with, it is satisfactory to all parties, and the river takes the place of an expensive wet dock. Adequate moorings, both swinging and fixed, have, however, been provided for vessels, and various regulations made for the proper control of the cargo boats.

In the absence of a dock the import trade required deep-water wharves along which sea-going vessels could lie and discharge their cargoes, and sheds and warehouses into which goods could be landed and stored. These have been provided to an extent sufficient to give a berth to every steamer requiring accommodation whether for the foreign or coasting trade. An important trade at Rangoon is that carried on by the river steamers which penetrate, *via* the Irrawaddy River, to nearly every part of Burma, and extensive accommodation in the shape of floating pontoon stages, sheds, and warehouses has been provided above the deep-water wharves. The port is fed by the Burma Railways Co. in addition to the river steamers, between which a wholesome competition exists.

Between 1900 and 1914 the revenue of the port increased from 12 lakhs to 52 lakhs, the net registered tonnage of shipping entering the port from 1,500,000 to 3,000,000, and the value of trade from 2,326 lakhs to 5,775 lakhs.

Like other river ports, Rangoon has had its troubles with its line of communication to the sea, the chief of which necessitated the building of a training wall two miles long at a cost of a million pounds in order to prevent the river changing its course and leaving Rangoon high and dry. This work was successfully accomplished, and a problem now in course of solution is the cutting of a channel through a shoal at the junction of three rivers a mile or so below the port, which prevents steamers of heavy draught having access at all times to the wharves and moorings.

The Port Commissioners are aiming at a 30-ft. channel from the sea to Rangoon at ordinary tides, and although the work will involve a large expenditure, and is, to a certain extent, experimental, they are prepared to take the risk.

In my opinion, Rangoon as a port is still in its infancy, and the Port Commissioners need to be very far-seeing and courageous or they will fail to keep pace with the times. Burma is a country with vast potentialities which are only beginning to be recognised, its mineral wealth and forests are almost untapped, and the agricultural possibilities, particularly in sugar, are enormous. The port cannot expect to continue

to conduct all its export trade in the stream, as in the near future goods for export by the thousands of tons will come down from Upper Burma by rail. A large, well-equipped export wharf is required, a site for which has already been selected; additions and extensions to the import wharves and river-steamer wharves, more warehouses, and a dry dock, are other works which are indicated.

Chittagong.—Chittagong was an important place so long ago as the sixteenth century, when it was controlled by the Portuguese, but very little was done to the port, and before the advent of the Assam-Bengal Railway there were practically no land communications with the interior. The principal export trade was jute, which was conveyed in sailing brigs from Narayanganj and transhipped at Chittagong into seagoing vessels.

There was no trade in tea, and a comparatively small import trade.

In 1887 a Port Trust was created, but the mere creation of a Port Trust with powers under an Act of the Legislature does not make a port, and the trustees began their career with neither money, credit, equipment, foreshore land, nor experience of port administration. Up to the year 1892 there was no thought of developing the port, and although the Commissioners had powers under their Act to acquire land and to construct wharves they preferred to give authority to private individuals to erect jetties, and were commended by the local Government for keeping out of debt. In 1892, when the Assam-Bengal Railway with its terminus at Chittagong was under construction, the Port Commissioners awoke to the fact that they had no foreshore land on which to build seagoing jetties, and no money either to purchase land or to build jetties. Thereupon followed a lengthy correspondence with Government and the appointment of committees, sub-committees, and special experts. The Government of India said it was obviously the duty of the Port Commissioners to build jetties and otherwise provide all facilities for the landing and shipping of goods, and the Port Commissioners were ordered to carry out the functions for which they had been created. But finally, as the Port Commissioners had no money and Government declined to assist them either by grant or loan, the railway company were empowered to construct and manage such wharves as were necessary to provide terminal facilities for their traffic. One step led to another, and the railway company have now been given entire control of the port and the river.

The history of Chittagong port is a striking example of how things ought not to be done, and an argument in favour of some measure of Imperial control of Indian ports.

The Chittagong River has, through neglect, fallen into a shocking state, and an expenditure of 100 lakhs, together with a considerable recurring expenditure, will be necessary to make it navigable at all times for large vessels, and now that the Chittagong-Akyab Railway is to be built it is for consideration whether the railway would not do well to make Akyab the chief marine terminus, as an excellent port can be made there at comparatively little cost.

Madras.—Madras is the only British port, with any pretensions to the name, between Bombay on the west coast and Calcutta on the east coast of India, and it is perhaps open to question whether it was wise to attempt the construction of a large port in that particular locality, exposed as it is to the full force of the south-west monsoon.

Proposals for an artificial harbour were first made in 1868, and were sanctioned by the Secretary of State for India in 1875. The works were begun in 1877, and in 1881 the breakwaters were severely damaged by a cyclone, and it was not until 1895 that the harbour, on its original plan, was completed. The harbour was not, however, a success, as so far from being a refuge, there was so much disturbance inside the harbour that on the approach of a storm shipmasters preferred to go outside to the open sea.

Experts were called in, and discussed for many years whether the entrance for shipping ought to be on the eastern side, facing the sea, or in the north-east corner under a sheltering arm, and finally it was decided to adopt the latter course, and to close the existing entrance. This work was completed about the year 1910, and has proved fairly successful, but although the harbour is now smooth enough for working cargo out of lighters alongside ships and piers in ordinary weather, in the event of a cyclone all commanders of vessels are recommended by the port authorities to go out to sea as soon as the great danger signal is exhibited on the port flagstaff. The artificial harbour is, in fact, as described by Sir Francis Spring, the late Chairman, "a challenge flaunted in the face of Nature, which in revenge gets in a home thrust at intervals."

In other respects, between 1904 and the present time, the harbour has been completely remodelled and provided with modern equipment, deep-

water wharves, sheds, warehouses, and all the appliances of a modern port.

The total trade of the port is 139 lakhs of rupees, and the revenue and expenditure are in the neighbourhood of Rs. 16 lakhs and Rs. 14 lakhs respectively, whilst the total tonnage handled amounts to between 600,000 and 700,000 tons per annum.

Madras will never be a great port, and may even lose a portion of its trade when cheaper ports are opened up in the vicinity.

The Ports and the War.

The effect of the war on the ports is shown in the tables annexed to this paper, from which it will be seen that the western ports of Bombay and Karachi rather increased their trade than otherwise; Calcutta was seriously hit, and Rangoon was hardly affected. The reason for the prosperity of Bombay and Karachi was, that they were the two ports from which were shipped India's contribution to the war, in the shape of men, materials, and foodstuffs, and were the base depots for the Mesopotamia and East Africa campaigns.

Owing to the shortage of tonnage, exports from Calcutta were, to a great extent, railed from Calcutta to Bombay, but there being no rail communication with Burma, Rangoon had to be supplied with tonnage for the shipment of the rice crop.

On the whole, however, it is matter for congratulation and wonder that the ports of India suffered so little from the war, and that, thanks to our Navy and Mercantile Marine, trade was maintained even during the worst period of the submarine offensive.

Calcutta.—Between 1913–14 and 1918–19, the ordinary revenue of Calcutta Port dropped from 151¼ lakhs in 1913–14 to 118½ lakhs in 1917–18, after which trade revived and the revenue increased to 138½ lakhs in 1918–19. Unfortunately, there was no reduction in expenditure, which was 156½ lakhs in 1913–14, and about the same in 1918–19. It was therefore necessary to put on a war surtax, which from 5 lakhs in 1914–15, increased to no less than 52 lakhs in 1918–19. The net registered tonnage of vessels visiting the port dropped from 4¼ million to 2¼ million, coal exports from 3 million tons to 1⅓ million, and imports from 1,800,000 tons to 1,050,000.

Bombay.—The ordinary revenue of Bombay increased from 95¾ lakhs in 1913–14 to 188½ lakhs in 1918–19, but the expenditure increased from 79¼ lakhs in 1913–14 to 176¾ lakhs in 1918–19, and in the latter year there was in addition a small war surtax amounting to 4 lakhs. The net registered tonnage of shipping engaged in trade, *i.e.*, exclusive of transports, dropped from 4,656,000 to 3,785,000. Turning to trade, there was a great falling off in imports, iron and steel dropping from 238,000 tons to 29,000 tons, but coal exports increased from 106,000 tons in 1913–14 to 973,000 in 1916–17, and dropped to 720,000 in 1918–19. Grain exports remained level, but manganese ore dropped from 612,000 tons to 184,000 tons, and cotton bales from 2,195,000 bales to 951,000 bales.

During the war 3,245 transports and 893 hospital ships either entered or left the port, and the total number of troops and *personnel* passing through the port amounted to 2,297,924, of which over half a million were either sick or wounded.

The coal railed into the docks during the war for bunkering hired transports and hospital ships came to 2,453,210 tons, and the quantity of stores shipped in transports, or landed from them, between November, 1916, and December 31st, 1919, was 2,280,353 tons.

Karachi.—The revenue and expenditure remained fairly steady. The ordinary revenue in 1913–14, was 47 lakhs; in 1915–16, 33½ lakhs; and in 1918–19, 53 lakhs; ordinary expenditure, 38⅓, 36¾, and 52½ lakhs respectively. Karachi has only one export trade, viz., wheat, and that fluctuated from 907,000 tons in 1913–14 to 550,000 tons in 1915–16, rising to 1,051,000 in 1917–18, and dropping to 399,000 tons in the famine year of 1918–19.

Rangoon.—In 1913–14 the revenue was 51¾ lakhs; in 1918–19, 48¾ lakhs; and the expenditure, which was 37 lakhs in 1913–14, increased to 42½ lakhs in 1918–19. A small surtax was put on in 1917–18, which brought in 3 lakhs, but it has now been taken off. The tonnage of shipping, which was 2,937,000 in 1913–14 was 2,300,000 in 1918–19. Imports dropped from 1,230,000 tons in 1913–14 to 713,000, but exports increased from 3,300,000 to 3,374,000 tons in 1918–19.

Taking all things into consideration, the ports of India, except Calcutta, have come well out of the war, and their rates and dues have been very little increased, whilst the interference with trade has been of a purely ephemeral nature.

Port Administration.

The administration of the major Indian ports has followed that adopted in other parts of the

British Empire. In the first instance, the ports were either managed by municipalities, who were apt to regard the port as a useful contributor to the town revenues, and to divert the port funds to municipal purposes, or they were controlled by Government through an officer known as the Master Attendant. Finally, as the ports grew in importance, they were created corporate bodies, with functions and powers granted by the legislature, and were to a certain extent permitted to work out their own salvation, so long as they did not make too frequent demands on the public purse.

The principal features of these Indian Port Trusts are as follows, although differing slightly at various ports.

The Board, except at Calcutta, usually consists of a whole time chairman, who is the chief executive officer and general manager, and is appointed by the local Government, a certain number of trustees, either holding their appointments *ex officio* or nominated by Government, and a number of elected trustees, the latter being generally chosen by the European and Indian Chambers of Commerce and Trade Associations.

The Board has definite powers and can levy rates and dues on vessels and goods according to schedules which have to receive the sanction of the local Government and be published in the local *Gazette*.

The Board can borrow money with the previous sanction of the local Government, or the Governor-General in Council, according to the amount to be borrowed.

The Board is under an obligation to prepare an annual estimate of revenue and expenditure and to submit the same to the local Government for sanction, and the Board can prepare and sanction a schedule of staff.

In the matter of works, a list of those to be undertaken is given in the Act, and no work exceeding in value sums varying from fifty thousand to two lakhs of rupees can be executed, unless plans and estimates have been approved either by the local Government or in certain cases by the Governor-General in Council.

Finally, Government reserves to itself the right of control in various ways, and the accounts are audited by the Government Audit Department.

In addition to their own Acts, the Port Trusts are affected by the Indian Ports Act, under which port dues are levied, the Sea Customs Act, and various other Acts and Orders.

The Port Trusts usually have their own home agents, through whom machinery and stores are purchased, and their own consulting engineers, who give an opinion when asked to do so.

Generally speaking, the Port Trust Acts are well thought out, and, on paper, appear to be effective, whilst the control by Government is most complete.

The minor ports are administered by the local Governments direct through the Marine Department. In Madras an officer known as the Presidency Port Officer, who is usually a senior officer of the Royal Indian Marine, manages the ports with the assistance of local port officers and local advisory bodies, and in Burma there is a Royal Indian Marine officer at each minor port, who is under the orders of an officer in Rangoon called the Principal Port Officer, Burma.

Railway Ports.—There has recently been an innovation in the general policy of port administration, and two railways have been entrusted with the control and management of ports, the Bengal-Nagpur Railway at Vizagapatam, which is under construction, and the Assam-Bengal Railway at Chittagong.

Defects of Present System of Port Administration.

The defects of administration under Port Trusts are similar to those that obtain elsewhere, viz., that local bodies are apt to look at port affairs chiefly from their own standpoint instead of from the larger and Imperial point of view, and that they are as a rule devoid of imagination and courage and prone to opportunism.

A Port Trust in India labours under immense difficulties compared with similar institutions in Great Britain. Amongst others, they suffer from (*a*) lack of competent supervision and often of competent counsel; (*b*) the constant change of *personnel* whereby it is rare for any one individual or set of individuals to see the fructification of their policy. Moreover, the majority of the members of an Indian Port Trust are very ignorant of port work, and the Europeans, who are often on the verge of retirement, take, as a rule, but little interest in schemes which will only come into being after they have left the country. The members and staff have also not the opportunities of acquiring experience such as is obtained in the United Kingdom, where officials and trustees of ports have ordinarily only to take a short railway journey to compare notes with any one of fifty neigh-

bouring ports. As in all administrative work in India (and not only in India), the personal equation is generally the most important factor in efficiency, and affairs are left largely in the hands of a whole-time chairman, who, unfortunately, is at times selected without any previous experience of port work, and at the time of his appointment only knows a port as a place he passes through on his way from and to England. This is, in my judgment, a grave mistake. The management of a railway is not as a rule entrusted to a man whose sole experience has been that of a passenger, but to an officer who has worked his way through the various grades; and I see no reason why the management of a port should not be dealt with on similar lines. A chairman who is not an expert is more or less in the hands of his Board, and when, as frequently occurs, there is divergence of interest among the mercantile representatives, he is apt to take the line of least resistance and vote with those who are most insistent.

I do not wish to assert that a member of the Indian Civil Service, Public Works Department, or the mercantile community, if no one with practical experience of port work is obtainable, cannot make an efficient head of a Port Trust, provided he is given an opportunity of obtaining the necessary experience; but, in my opinion, a person with no previous experience should, before being appointed, work for at least a year in the offices of the port as a student and thereafter be given a year to study port affairs at the great ports of the world, in order to fit him to bring sound judgment to bear on the many and diverse problems he will have to deal with, and to recognise the national as well as the local interests frequently involved in questions that come before him.

The same lack of knowledge and experience in port administration is met with when references are made to higher authority. Questions of policy and schemes of improvement that are beyond the powers of the Port Trust are referred to the local Government or to the Government of India, as the case may be. But, as it is rare to find anyone at the headquarters of Government with a practical knowledge of ports, these questions are seldom decided strictly on their merits, and as it is always safe to question expenditure, an easy way of disposing of a case is on financial grounds. When I went to Rangoon in 1901, as Chairman and Chief Engineer of the Port Trust, I found the province being slowly strangled for lack of port accommodation and development. Not only were port facilities deficient, but there was no port staff, and I found myself saddled with the duties of Chairman, Chief Engineer, Secretary, Chief Accountant and Traffic Manager.

By a certain amount of strenuous work I had got affairs into some shape and order and had elaborated a scheme for port improvements. I then asked for some assistance in the shape of a secretary and a couple of assistant engineers, my proposals being cordially supported by my colleagues on the Board. In those days the Rangoon Port Commissioners had to ask the sanction of Government to any expenditure, a case in point being the increase in the pay of the cook on the pilot vessel by a shilling a month, and such a serious increase in the staff as the appointment of a secretary and two engineers was viewed with alarm and suspicion by the local Government, who informed the Port Commissioners that their proposals were *primâ facie* extravagant and unsupported by adequate reasons, and told me I was an expensive luxury. At a later date an important work of improvement at the Port of Rangoon was delayed for three years, because the Government of India had no engineer experienced in work on tidal rivers, whilst only recently when I held a war appointment in Simla, port questions were frequently referred to me, because, as one high official remarked, "there was no one in Simla who knew anything about ports."

Naturally under these circumstances no use is made by Government of the power given to it in the Port Acts to insist on the execution of necessary works.

Minor Ports.—The defects in the administration of minor ports are similar to those in major ports, but are accentuated by constant shortness of funds, colossal ignorance, and a general lack of interest in their development.

Railway Ports.—The administration of railway ports has not yet come into actual operation, and although there is a good deal to be said in their favour under special circumstances and conditions, I view with a certain amount of misgiving the decision of Government to establish railway ports in India; it is, moreover, a complete departure from the previous policy of the Government of India.

By a railway company, a port is merely regarded as a feeder to their particular railway system, and not for the general welfare of the community, and port traffic which is destined for the railway is encouraged at the expense of traffic which does not require railway

facilities; whilst, by charging specially low port dues and charging the deficit to the railway revenues, a railway port can compete unfairly with Port Trusts, who are limited by their Acts to the provision of port accommodation.

Calcutta has very good reason to complain of the action of Government in giving Vizagapatam and Chittagong to railway companies, because not only can they compete in an ordinary and perfectly fair way by the capture of trade—and there is no doubt a great percentage of Calcutta's trade will go to Vizagapatam if the railway company succeeds in making a port there—but because of the special facilities granted in the matter of raising capital for the construction of the port.

Calcutta, as a Port Trust, has to go to the public for a loan, which involves the upkeep of a sinking fund; but a railway company can be provided with funds either from advances by the Secretary of State, or by issue of debentures or debenture stock by the railway company, or by the issue of further ordinary shares; and the formation of a sinking fund for repayment of capital expenditure is not usually contemplated.

The railway also possesses a monopoly of terminal facilities for its own railway, and competition by other railway lines or by inland water transport is usually regarded with disfavour, regardless of the fact that the port with the best prospects and the one that is of the greatest use is that which has the widest choice of transporting facilities to the interior.

(*To be continued.*)

THE PRINCIPAL INDUSTRIES OF THE SERB-CROAT-SLOVENE STATE.

The following particulars regarding the principal industries of the State of the Serbs, Croats and Slovenes are extracted from a document prepared by the State Minister of Commerce, and translated by the American Embassy at Belgrade:—

While it is difficult to describe the industrial conditions in the new Provinces, it may be said generally that the country has considerable stocks of raw materials, and conditions are favourable for developing various industries. There are in the Western part large quantities of coal and wood, a considerable amount of water-power, and many trained workmen; but the industries encounter great difficulties as they are dependent upon foreign capital.

The metal industry was first developed in the western part of the country, but has not yet reached the point of turning out heavy metal pieces. This is due to the lack of modern equipment. According to the statistics of 1910, the manufacturing of metals was confined to nine works. The largest were the Government works at Kraguyevatz. Two smaller ones at Belgrade had a capital of 6,276,971 dinars, and an annual business of 12,000,000 dinars. There is at Wares, in Bosnia, a foundry able to manufacture 100,000 tons of iron, three-fourths of which was previously exported to Austria and Hungary. In Slavonia there is not much iron, and owing to this, only one foundry has been erected at Skednj, near Trieste, where in addition to Slavonia iron, Spanish, Algerian and Italian iron has been used. This establishment has manufactured about 10,000 tons per annum. There is an important iron industry in Jasenica and Yavornik, in Slavonia, which produces 30,000,000 crowns worth of various iron products. In Croatia there is also, to some extent, a developed iron industry. Various implements of iron and steel are produced in other enterprises in Slavonia. There are no foundries in Serbia. Investigation shows, however, that there are rich iron deposits, and it is expected that there will be a great development of the mining industry there.

In Bosnia and Herzegovina there are produced about 2,800,000 tons of brown coal and 130,000 tons of first quality coal. There are many deposits which are still untouched. Manganese mines with a yearly production of 20,000 tons, and some antimony and pyrites mines are also found here. Slavonia possesses lead mines with a yearly production of 18,000 tons, and zinc mines with a yearly production of 30,000 tons. In Idria (Slavonia) are the well-known quicksilver mines which produce 130,600 tons of ore yearly, from which are extracted 820 tons of quicksilver valued at 3,878,000 crowns.

The textile branch of industry has been so well developed that in 1910 the needs of the Army were covered by home productions. The thread was imported chiefly from England, and the raw material was partly obtained in the country and partly from Banat and Hungary. There were three wool-spinning mills with 6,120 spools and 180 spindles, which produced material valued at 2,500,000 dinars. The home clothing material industry in the district of Pirot was valued at 400,000 dinars in 1910. There are also two hemp-spinning works and a knitting factory in the country. Hemp factories are found in Batchka, Banat, Baranya, and Srem. In Trzich and Litija are some factories capable of producing 3,000 tons of cotton thread and 3,750 tons of cotton goods, but owing to the lack of cotton they are not now working.

The home carpet industry in the Pirot district is also worthy of note. Carpet factories are found at Sarajevo, Bosnia, and at Becskerik (Banat).

In Slavonia (Trzitch, Schoschtanj and Maribor) about 600,000 hides are worked. The boot and shoe factories produce about 1,000,000 pairs of boots and shoes. There is one factory at Temesvar, Banat, with a capacity of 800,000 pairs. There are similar enterprises in Croatia at Zagreb, Karlovatz and Osek. Serbia has two factories for manufacturing leather and hides, the value of the

manufactured hides of lower quality in 1908 being 1,117,462 dinars. The better quality of leather was imported.

There are in the country about fifty large mills with a production of 100,000 cars of flour. The up-to-date mills are especially in the Banat, Batchka, Baragna and Slavonia. In 1909 there were in Serbia 229 mills of the following capacities: 1 mill producing in 24 hours, 10 cars; 16 mills, 2 to 5 cars; 22 mills, 1 to 2 cars; 86 mills, ½ to 1 car; and 104 mills, 500 to 5,000 kilos. In 1909, 1,012 cars of flour and 861 cars of bran were exported. The total production in that year was estimated at 9,616 cars of flour and 3,540 cars of bran.

In the new Provinces there are six large and up-to-date sugar factories, the production of which will be quite sufficient for the country's needs. This industry has been fairly developed in Serbia. There is one factory at Belgrade which produced in 1909, 909 cars, and one in Tchuprija which produced in 1911, 840 cars.

There are important chemical works in Slavonia and Croatia. In Slavonia these are at Hrsnik, Celj, Ruhce and Liubliana. Sulphuric acid, glauber salts, and crystal and bicarbonate of soda are produced. At Kamnik there is a powder factory. Some very important tannin factories are found at Zupango and Mitrovitch, Croatia. In Bosnia (Yayce and Bosna Brod) are carbide works and refineries of petroleum and mineral oils with a capital stock of over 9,000,000 crowns. A considerable quantity of pure alcohol was produced in Batchka, Baranja and Banat, but this activity ceased owing to shortage of coal. The chemical industry has just been introduced into Serbia. In addition to the State powder works there were at Belgrade a few acid works, a soda works, two soap factories, a dye factory, and a match factory.

In the new Provinces there are many fine forests, and owing to the water-power available this industry has been greatly developed. There are about 2,300 sawmills, with 4,000 saws. The value of the products of the industry is about 100,000,000 crowns. The timber industry is developed on a large scale in Bosnia. In 1913, 2,500,000 cubic metres of wood were exported to Holland, Italy, Egypt and Germany. In Croatia there is also an important timber industry, and in Serbia there are about fifty sawmills, but only five of importance. The timber industry at present represents a very large part of the commercial budget of the country.

Other industries of the Serb-Croat-Slovene State which may be mentioned are brewing, electrical, paper, cement, glass, brick and tobacco. With the exception of a few mines, the larger part of the factories of the country were destroyed during the war by the enemy. It is hoped, however, that these industries will soon be reconstituted.

GRAPHITE DEPOSITS IN SIBERIA.

Extensive deposits of graphite exist in north-western Siberia on the left bank of the River Kureika, near its junction with the River Yenisei, ninety miles from the mouth of the latter river. The graphite area forms a horizontal plateau, the elevation of which varies from 20 to 50 ft. above the normal level of the River Kureika. The plateau contains two layers of graphite, which is of a solid, steel-grey colour, soft, and of an excellent quality for the manufacture of pencils.

The graphite mines of Siberia were discovered in 1859 by the celebrated explorer Sidoroff, who sent samples of the metal to Russian and foreign laboratories for analyses. These analyses gave the following chemical composition: 89·51 per cent. carbon, 0·60 per cent. hydrogen, and 9·89 per cent. residue. These analyses were confirmed in 1907. The carbon constituent is said to be superior in quality to that found in graphites in other parts of the world. The graphite is not inflammable and is very plastic.

At present, writes the United States Consul at Omsk, it is practicable to ship the graphite only during the summer months by sea from the Yenisei River through the Arctic Ocean. It is believed that in the future the graphites from these mines will supply Russian demands, and that large quantities will be available for export.

The chief sources of graphite have hitherto been Ceylon, Bohemia, Germany, France, and the United States. The annual world production has been, approximately, 120,000 short tons (of 2,000 lb.).

NOTES ON BOOKS.

Social Life in England through the Centuries. By H. R. Wilton Hall. London: Blackie & Son, Ltd.

Since the discovery was made that the history of a country is something more than a string of dates of battles, and of the accessions and deaths of kings and queens, a good deal has been done in the schools to make the story of the past appear to the scholars as something that once had life and still has interest, as showing how the present has developed out of what has gone before. Mr. Wilton Hall has written a book which, we think, should be useful in this respect, for he throws a great deal of light on the social life of this country from the days when its inhabitants lived in caves and pits. He gives us glimpses of the manner in which our ancestors lived at various stages of our history; he traces the development of Anglo-Saxon tuns and vills to wooden towns and villages, the evolution of houses, schools, universities, sports, roads, railways, etc. The book is illustrated with many excellent figures, and altogether it should prove a popular addition to the school library.

Water Powers of British Columbia. By Arthur V. White, Consulting Engineer, Commission of Conservation, Canada, assisted by J. Vick. Ottawa, 1919.

This report, which runs to nearly 650 pages, is a compendium of data relating to the water-power

resources of British Columbia. It opens with a statement of the principles which should be observed in the conservation and utilisation of inland waters, and discusses certain important features which should characterise reliable water-power data. This is succeeded by a comprehensive historical survey of water-power legislation in the Province, together with discussions of subjects cognate therewith. Tabular lists are given of the estimated possibilities of water-power sites, and these are largely based on results obtained from special field investigations conducted by the Commission of Conservation. Digests of stream-flow, meteorological and other hydrometric records follow, and the volume concludes with a full bibliography and index.

In a country like British Columbia, much of which is covered with lofty mountains and with dense forests, it is impossible to obtain anything like reliable estimates of the water-power. This is fully recognised in the report, which is careful to give only general and conservative estimates. The total, in round figures, is given at about 3,000,000 horse-power, of which the Columbia River and tributaries contribute 610,000; the Fraser River and tributaries, 740,000; Vancouver Island, 270,000; the mainland Pacific Coast and islands, 630,000; and the Mackenzie River and tributaries, 250,000. There is still a great deal of territory which it has not yet been possible to investigate fully, and these areas may be found capable of adding very considerably to the estimated powers.

The report is illustrated with a large number of photographs, which give an excellent idea of the beauty of the country, and also of the difficulties of the field investigators in making their way through some of the trackless regions.

The Mineralogy of the Rarer Metals. By Edward Cohen, A.R.C.S., F.I.C., and William Ord Wootton, A.R.C.S., B.Sc. Second edition. London: Charles Griffin & Co., Ltd. 10*s.* 6*d.*

The first edition of this book appeared in 1912. It was designed to meet the needs of prospectors and practical metallurgists, and it contained in a compendious and handy form a great deal of information which had hitherto been only obtainable in Dana's monumental work or in scattered monographs. It achieved so much success that a second edition has now been called for.

Since the publication of the first edition a great deal has happened to bring the rarer metals into greater prominence than ever before. Platinum, for instance, became very scarce and valuable during the war, with the result that research was stimulated in the hope of finding substitutes for it, and several alloys have been placed on the market which promise to prove of permanent value. Zirconium is another metal which has received a great deal of attention in recent years. The carbide is employed as a filament for incandescent lamps, and also as an abrasive. The oxide is used as a refractory body in the manufacture of zirkite bricks and small utensils for laboratory purposes, such as crucibles, muffles, combustion tubes, and resistance cones. Combined with yttrium earth oxides it is used in Nernst lamps, and as a substitute for calcium oxide in limelight cylinders. Its uses are being extended in other directions also, *e.g.*, for rendering opaque the enamel on hardware, and as a substitute for bismuth subnitrate in the making of X-ray photographs.

The book is arranged very conveniently, notes being given on the properties of each metal, its preparation, commercial applications, and detection. The sections on commercial applications and the chapter on "Geographical Distribution" have had to be rewritten and largely expanded.

The War Garden Victorious. By Charles Lathrop Pack. Philadelphia: J. B. Lippincott Company.

When the war broke out in 1914, between twenty and thirty million men were suddenly called away from their usual pursuits. The majority of these were engaged in agricultural pursuits, and thus at one blow practically all the farms of the belligerent nations were swept clear of male workers. The natural result of this was very soon seen in a world shortage of foodstuffs, which was greatly intensified by the general failure of crops in 1916. The burden of feeding the Entente countries fell to a large extent upon the United States, and it soon became necessary to take steps to make very large increases in the production of that country. At the instance of the author of this book a National War Garden Commission was formed, of which he became President, and with characteristic energy it set to work to educate the hundred million population of America in the needs of the hour. How this task was undertaken, and with what results, is told very effectively in the present volume. The American people (men, women, and children) rose nobly to the occasion. Over five million war gardens sprang into existence, and the value of their produce in 1918 was estimated at half-a-billion dollars.

The book is illustrated with a number of photographs showing gardens, some of which look very fruitful and attractive, canning teams—a great deal of excellent work was done in connection with drying and preserving food of all kinds; while not the least interesting part is the concluding section which contains a collection of the leaflets published and distributed by the National War Garden Commission.

GENERAL NOTES.

The Electrification of Seeds.—Mr. Martin H. F. Sutton has published an interesting bulletin giving the results of a number of germination and field tests conducted last year on carrot, swede, cabbage and mangold seeds. Experiments were made with untreated seeds, with seeds electrified by the Wolfryn process, in which the seeds are immersed in a solution of common salt and water

or of calcium chloride of water, through which an electric current is passed. After immersion the seeds were dried at a temperature of 100° F. and then sown. On the whole the tests do not appear to show any advantage from the treatment, with perhaps the exception of mangold, where the germination of the electrified seed was 94 per cent., as compared with 82 per cent. for the untreated seed; while in the field tests the electrified mangold seeds yielded 62 lb. per pole more than the untreated seed. In other cases either the electrified seed gave a lower yield than the seeds treated in other ways, or the increase was so small as to be negligible.

New Source of Alcohol.—Much attention has been given in recent years to the question of manufacturing alcohol within the Empire for use as motor spirit. In the current number of the *Bulletin* of the Imperial Institute the possibility of utilising the mowra flowers of India for the purpose is discussed. These flowers possess thick, juicy petals, rich in sugar. They are used by the natives as a foodstuff, and especially for the preparation by fermentation of an alcoholic liquor called daru or mohwa spirit. A single tree will yield as much as 200 to 300 lb. of flowers in a year. The tree also produces a valuable oil-seed, which is exported in fairly large quantities to Europe. During the war the flowers were used in India for the production of acetone, the yield being said to be ten times as much as that obtained by distilling wood, which is the usual source of this substance. The demand for acetone in India in peace times, however, is not great, and large quantities of the flowers would be available for the manufacture of alcohol, and would appear to be an exceptionally cheap source of this material, as the yield is high compared with that from potatoes and other materials commonly used, about ninety gallons of 95 per cent. alcohol being obtainable from one ton of dried flowers. It has been estimated that in the Hyderabad State alone there are already sufficient mowra trees for the production of 700,000 gallons of proof spirit per annum, in addition to that necessary for the local liquor requirements. It is suggested that the most profitable way of utilising the flowers would probably be as a source of mixed motor spirit of the "natalite" type for use in India. That motor spirit can be produced on a manufacturing scale in India from mowra flowers has already been demonstrated, and it is stated that running trials with the spirit proved satisfactory.

MEETINGS OF THE SOCIETY.

Indian Section.

Monday afternoon, at 4.30 p.m.:—

May 31.—Albert Howard, C.I.E., M.A., A.R.C.S., F.L.S., Imperial Economic Botanist to the Government of India, "The Improvement of Crop Production in India." Sir Robert W. Carlyle, K.C.S.I., C.I.E., will preside.

Friday afternoon, at 4.30 p.m.:—

June 18.—Sir Valentine Chirol, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.) The Right Hon. Lord Meston, K.C.S.I., LL.D., will preside.

Indian and Colonial Sections.

(Joint Meeting.)

Friday afternoon, at 4.30 p.m.:—

June 4.—Professor Sir John Cadman, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E., "The Oil Resources of the British Empire." The Right Hon. E. G. Pretyman, M.P., will preside.

Cantor Lecture.

Monday evening, June 7th, at 8 p.m. (lecture postponed from April 26th):—

Walter Rosenhain, B.A., D Sc., F.R.S., Superintendent, Department of Metallurgy, National Physical Laboratory, "Aluminium and its Alloys." (Lecture III.)

Syllabus.

Special Uses of aluminium alloys—Castings for automobile and aeroplane parts—Castings for aero-engines—Pistons and piston alloys—Properties at high temperatures—Automobile and aero-cylinders—Other engine parts—Structural uses—Rigid airships, aeroplane spars, and wing-coverings—Possible future developments.

MEETINGS FOR THE ENSUING WEEK.

Tuesday, May 25...Royal Institution, Albemarle-street, W., 3 p.m. Major C. E. Inglis, "The Evolution of Large Bridge Construction." (Lecture I.)

Wednesday, May 26...Aeronautical Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Sir Richard Glazebrook, "Some Points of Importance in the Work of the Advisory Committee for Aeronautics."

Thursday, May 27...University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Mr. E. H. C. Walsh, "Tibet."

Royal Society, Burlington House, W., 4.30 p.m.

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 7.30 p.m. Major H. Best, "The Mystery Port, Richborough."

Friday, May 28...Royal Institution, Albemarle-street, W., 9 p.m. Professor W. L. Bragg "Crystal Structure."

Physical Society, Imperial College of Science, South Kensington, S W., 5 p.m.

Saturday, May 29...Royal Institution, Albemarle-street, W., 3 p.m. Dr. J. H. Jeans, "Recent Revolutions in Physical Science. (1) The Theory of Relativity."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

Monday, May 31st, at 4.30 p.m. (Indian Section.) Albert Howard, C.I.E., M.A., A.R.C.S., F.L.S., Imperial Economic Botanist to the Government of India, "The Improvement of Crop Production in India." Sir Robert W. Carlyle, K.C.S.I., C.I.E., will preside.

Friday, June 4th, at 4.30 p.m. (Joint Meeting of Indian and Colonial Sections.) Professor Sir John Cadman, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E., "The Oil Resources of the British Empire." The Right Hon. E. G. Pretyman, M.P., will preside.

Further particulars of the Society's meetings will be found at the end of this number.

POSTPONED CANTOR LECTURE.

The third lecture of the course on "Aluminium and its Alloys," by Dr. Walter Rosenhain, F.R.S., Superintendent of the Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, which was postponed from April 26th, in consequence of the sudden illness of the lecturer, will be delivered on Monday, June 7th, at 8 p.m.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

THE PORTS OF INDIA: THEIR ADMINISTRATION AND DEVELOPMENT.

By Sir George Buchanan, K.C.I.E.

(*Continued from page* 441.)

Proposed Improvements in Port Administration.

I have pointed out some defects in the existing system of port administration, and will now put forward some suggestions for reform.

On the whole I am in favour of a continuation of control by bodies of men representing the various interests, not because it is the most efficient method of working a port, a municipality, or any other public undertaking, but because it has been our policy for many years to encourage local self-government. That it is not essential to create a Port Trust with a large number of members is shown by the fact that one of the best-managed ports in the world is Montreal, with a Harbour Commission of three —a President and two members—and one of the worst-managed ports is Calcutta, with a Commission sixteen in number.

Assuming, however, that the ports continue to be managed by bodies of trustees, I am of opinion that their powers and responsibilities should be materially increased, and that the chairman should be a well-paid, practical and thoroughly competent man invested with considerable authority and wide powers, especially in matters of detail. I have also for a number of years held the opinion that there should be a system of unified direction and control of ports by the Imperial Government of India, who should take a much livelier interest in the higher policy of port development, and the co-ordination of ports with interior transport.

At the present time the Government of India is supposed to exercise a control over ports in various ways, viz., new legislation, approval of loans, sanction to execution of works, etc.; but although the Government of India has Railway, Irrigation, Medical, Agricultural, Public Works, and other departments with experts attached to each, it has no officer or officers at headquarters with special knowledge or interest in ports, the result being that port matters are bandied about from one department to another and finally, I believe, find a resting-place in the Education Department.

Port development is, however, just as important as railway or road development, the port

forming one of the three links of transportation, viz., ship, port, and railway, or road, or river, whilst transportation is a cost of production equally with materials and labour.

The Chairman of the Dominions Royal Commission, in an address to the London Chamber of Commerce on the subject of the improvement of sea communications, advocated a bold and progressive policy of harbour construction for the accommodation of large ships. In his address, Lord D'Abernon pointed out that the pre-war facilities for commercial intercourse by sea were far below the best available standard, that there was little scientific anticipation of coming events, and still less was there preparation on a generous scale for future possibilities, whilst it seemed, indeed, as if other nations had applied to the problem of harbour development a clearer vision of the future and a broader comprehension of progressive tendencies.

He proceeded to point out that this condition of affairs could hardly be altered scientifically so long as harbour development was left to isolated and independent action by individual harbour authorities, and that the responsibility for development of harbours along great ocean routes must be dealt with by superior State authority, acting independently of the immediate interest of individuals.

To those who have studied the subject, there is nothing new in Lord D'Abernon's statement, and more or less the same opinion was expressed some years ago by the Royal Commission on the Port of London, who, in their report, commented on the difficulty of creating a port without State aid, and when discussing the great development made by the Continental ports in the last few years, principally owing to lavish expenditure on the part of the State, remarked :—

"The power of undertaking large expenditure and of working for a long time at a loss, with a view to compensation in a distant future, is no doubt in the keen world competition an advantage possessed by undertakings which have the force of Empire, State, or a great city behind them. If in some countries national and municipal resources are thus employed, it becomes most difficult for private enterprise elsewhere to hold its own against the intelligent, far-sighted, and formidable rivalry thus created."

It is an unfortunate fact that in India there has been no really comprehensive or scientific inquiry into India's port requirements, and the ports have struggled on with little encouragement, little financial assistance, and no advice. I do not remember that during the whole time I was in Rangoon one useful suggestion for the betterment of the port ever came to the Port Commissioners from either the Local Government or the Imperial Government—not that they did not care, but because port work was unfamiliar to them.

The best solution of the whole problem would, in my opinion, be the creation of a Department of Communications to deal with railways, inland waterways, and ports, roads being left to the local Governments. In regard to ports, the control should be in the shape of guiding the policy in the interest of the Empire, rather than interference with detail, but there should be, at the same time, an insistence on the execution of vitally important works, such as, for instance, the improvement of the Hooghly River, and the provision at Karachi of adequate facilities for the grain trade. The Port Trusts should also be helped financially, by Government including in its loans the sums required for port development, the money being transferred to the port authority at a slightly enhanced rate over and above the Government loan terms. At present the Government contents itself by scrutinising the application of a port authority to float a loan, before sanctioning its issue, and by seeing that the loan is not put upon the market until all Government loans have been floated and disposed of.

In this connection I also suggest that there should be a more comprehensive inquiry by competent authority than at present exists into the cost and necessity for works often involving a great expenditure. In the United Kingdom new projects for ports, waterways, or docks are considered by Committees of the two Houses of Parliament, and the very best expert evidence is obtained and laid before them, whilst, in the case of an opposed Bill, frequently weeks are taken up in hearing counsel on both sides and examining witnesses. There is a full ventilation of objections, and the final decision of the Committee is accepted as disinterested and sincere. One could not imagine in this country, for example, a railway company being permitted to build a port and given preferential treatment over a neighbouring Port Trust without the fiercest opposition on the part of the Port Trust, and action on the part of the port bondholders. I often wonder that the debenture and bondholders of the Indian ports do not take more interest in their administration, because, so far as I am aware, the Government of India does not guarantee the various loans, and there is no reason why, under the influence of bad management and misfortune, a

port should not find itself unable to meet its liabilities, as happened recently in the case of a home port.

A new department, such as I have described, composed of men of real knowledge and experience, would be of enormous value in developing India. I should, however, deprecate the new department bearing any resemblance to the present Railway Board, and I think it would be necessary to recruit some of the members and the staff from outside India, and to pay them on a commercial rather than a Government basis.

Port Development.

The immense amount of work that must be done in the future in India in port development is not generally realised, and as first and foremost there must be a sufficient depth of water in the river and harbour entrances, it will be well to consider what will possibly be required in the years to come.

East of Suez, port development has been largely guided by the size of vessels which can pass through the Suez Canal, and although the war awakened the Indian ports to the fact that there is an alternative route round the Cape, and a number of vessels visited India which could not have passed through the Canal, the depth in the Canal is the key to the situation. Before 1884, the maximum draught of vessels permitted was 24 ft. 6 in.; in 1901, 25 ft. 7 in.; in 1907, 27 ft., and at the present time, 30 ft., whilst the scheme of improvements now being carried out aims at permitting the transit of mercantile vessels of 33 ft. draught. Supposing we add 2 ft. to the proposed draught of 33 ft., and make 35 ft. the maximum to work to in the near future, then, according to a recent ruling, there should be 40 ft. of water in entrance channels through sea bars, 37 ft. in ordinary entrance channels, and 36 ft. in wet docks and alongside quays and wharves. That is to say, there is not a single port in India which could take a vessel of such a size. Not only do we require existing ports improved and extended and their spheres of influence and transport facilities behind the port critically examined, but the development of new ports, wherever demanded by trade, such ports competing fairly with others in the neighbourhood, and being controlled by local committees.

There are several ports in Southern India worthy of development, and for the last thirty years report after report by engineers has been received, considered, and put aside. In my judgment this is not the way to approach the subject, as what is required in the first instance is a careful examination and report on the prospective trade of the port, the area of country to be tapped, the possibilities of increasing that area, and giving better transport facilities to the port, also the prospective revenue and maximum capital expenditure permissible to begin with. Armed with this information, the engineer can and must cut his coat according to his cloth and say what can be done for the money. A grandiose scheme prepared without this information is a mere waste of time. One has also to consider the vested interests that exist at nearly every port in the shape of rights and privileges held by individuals or trading companies, as by the disregard or neglect either to compound or make use of these, the development of many a port has been postponed for years. It is therefore generally better to assimilate these interests and to make use of them for the public good rather than to keep them in opposition.

It must also be remembered that the success of a port depends on its management as much as its engineering, and that the two branches must work hand in hand, constantly devising schemes for the giving of better facilities for trade, as a port can never be said to be completed, and there are very few ports which could not have their expenditure reduced and their revenues increased by improved methods of administration.

The new port of Basra is not an Indian port, but it is being developed on the lines of Indian ports, and I am therefore tempted to use it as an illustration and warning, because I am afraid nearly all the defects I have pointed out in this paper on port development and administration can be seen there, either active or in embryo. In the arrangements for the conversion of the port from war to civil requirements, there has been no competent counsel, and there has been no properly thought-out scheme for the administration of a civil port, by people versed in port affairs. A Port Trust is to be established, but, as I have already pointed out and illustrated by examples, the creation of a Port Trust does not make a port.

Schedules of rates and rules and regulations have been copied from other ports, regardless of the fact that a new port in a new country requires individual treatment, and the rates have been fixed on a scale which will make Basra one of the expensive ports of the East. This is a matter for regret, because the immediate future of Mesopotamia and Persia lies as much

in correct port administration and development as in anything else.

I am afraid this paper has reached an inordinate length, and I do not expect that the views I have expressed will meet with universal approval. The paper will, however, have served its purpose if it provokes discussion, and induces my audience and the public at large to realise that there is a great deal of work to be done in developing Indian ports, and that it is useless to create a vast industrial India if there is not at the same time a wise and far-seeing scheme for improving and developing ports and transportation facilities in general.

TRADE STATISTICS, 1913-14 TO 1918-19.—I.

Year	Name of Port.	Ordinary Revenue exclusive of Pilotage.	War Surtax.	Total.	Ordinary Expenditure.	Revenue Reserve.	Interest and Sinking Fund on Loans.	Debt.	Net Registered Tonnage of Shipping entering the Port engaged in Trade.
		Lakhs of Rupees.	Lakhs of Rupees.	Lakhs of Rupees.	Lakhs of Rupees.	Lakhs of Rupees.	Lakhs of Rupees.	Lakhs of Rupees.	
1913–14	Bombay	95·76	—	95·76	79·27	89·09	53·49	1296·65	4,656,515
	Calcutta	151·28	—	151·28	156·61	27·08	60·05	1052·00	4,256,987
	Rangoon	51·84	—	51·84	37·03	6·30	15·57	298·62	2,937,221
	Karachi	47·14	—	47·14	38·33	35·00	14·72	228·64	2,056,379
1914–15	Bombay	99·95	—	99·95	116·16	87·67	63·07	—	3,834,200
	Calcutta	139·39	5·11	144·50	155·38	21·25	62·46	1052·00	3,714,344
	Rangoon	45·38	—	45·38	41·29	9·53	17·47	298·62	2,423,048
	Karachi	—	—	—	—	40·47	—	—	1,933,154
1915–16	Bombay	115·31	13·02	128·33	131·18	85·10	68·05	1478·65	3,427,331
	Calcutta	132·38	26·97	159·35	149·07	21·75	63·57	1220·98	2,967,798
	Rangoon	45·37	—	45·37	39·84	9·85	17·84	298·62	2,193,219
	Karachi	33·64	—	33·64	36·76	40·47	15·95	261·21	1,957,467
1916–17	Bombay	154·40	17·01	171·41	152·56	81·22	72·10	1530·65	3,285,705
	Calcutta	130·63	26·60	157·23	156·31	21·75	62·31	1247·09	2,804,680
	Rangoon	45·12	—	45·12	39·99	11·78	17·80	298·62	2,074,892
	Karachi	44·12	—	44·12	36·77	40·47	15·88	260·03	2,522,945
1917–18	Bombay	170·88	4·64	175·52	159·05	86·34	76·00	1530·65	2,602,903
	Calcutta	118·49	39·90	158·39	156·29	21·75	62·88	1245·80	2,094,011
	Rangoon	41·09	0·35	41·44	40·75	11·51	17·72	298·62	1,775,834
	Karachi	63·15	—	63·15	46·63	34·64	15·78	258·84	3,074,606
1918–19	Bombay	188·62	3·99	192·62	176·80	89·65	74·84	1547·65	3,785,015
	Calcutta	138·52	52·06	190·58	156·14	46·75	60·47	1241·62	2,229,462
	Rangoon	48·84	3·42	52·27	42·55	12·78	17·50	298·62	2,031,612
	Karachi	52·90	—	52·90	52·59	36·64	15·59	257·61	2,367,883

TRADE STATISTICS, 1913-1914 TO 1918-19.—II.

BOMBAY.

Imports.

Year.	Coal.	Grain.	Iron and Steel.	Sugar.	Timber.
	Tons.	Tons.	Tons.	Tons.	Tons.
1913-14	656,000	298,000	238,000	225,000	102,000
1914-15	588,000	288,000	175,000	97,000	92,000
1915-16	109,000	331,000	84,000	172,000	99,000
1916-17	47,000	320,000	53,000	160,000	132,000
1917-18	73,000	207,000	33,000	158,000	139,000
1918-19	50,000	445,000	29,000	136,000	86,000

Exports.

Year.	Coal.	Grain.	Manganese Ore	Cotton Bales.	Seeds.
	Tons.	Tons.	Tons.	Number.	Tons.
1913-14	106,000	451,000	612,000	2,195,000	822,000
1914-15	355,000	249,000	365,000	2,248,000	518,000
1915-16	673,000	339,000	438,000	2,102,000	433,000
1916-17	973,000	402,000	349,000	1,795,000	513,000
1917-18	926,000	604,000	246,000	1,867,000	263,000
1918-19	720,000	418,000	184,000	951,000	295,000

TRADE STATISTICS, 1913-14 TO 1918-19.—III.

Calcutta.

Year.	Docks.			Jetties.
	General Exports.	Coal Exports.	Imports.	
	Tons.	Tons.	Tons.	
1913-14	1,231,589	3,017,180	613,876	1,186,797
1914-15	920,659	2,633,805	700,133	917,978
1915-16	1,054,985	1,610,645	570,997	788,431
1916-17	1,185,159	1,994,528	444,210	686,010
1917-18	995,112	1,014,993	363,383	633,693
1918-19	1,098,000	1,333,000	482,000	575,000

Rangoon.

Year.	Total Tonnage Imports.	Total Tonnage Exports.
1913-14 . . .	1,231,377	3,303,347
1914-15 . . .	1,048,848	2,739,693
1915-16 . . .	1,041,776	2,594,122
1916-17 . . .	956,289	2,761,309
1917-18 . . .	737,961	2,490,015
1918-19 . . .	713,191	3,374,023

TRADE STATISTICS, 1913-14 TO 1918-19.—IV.

Karachi.

Year.	Exports.		Imports.
	Wheat.	Total of all Shipments.	Landed at Wharves.
			Tons.
1913-14	907,962	1,483,069	1,067,004
1914-15	731,494	1,015,863	697,958
1915-16	550,465	1,172,221	314,371
1916-17	679,390	1,628,629	204,128
1917-18	1,061,865	3,060,390	161,115
1918-19	399,576	1,862,399	175,242

DISCUSSION.

THE CHAIRMAN (The Right Hon. Edwin S. Montagu, M.P.) said he did not propose to discuss the paper, because he was present to listen and to take note rather than to talk on so very technical a subject. The author had confessed that his paper was highly controversial, and they could only hope that among those who would take part in the discussion there would be some full-blooded and lusty members of the Calcutta Port Trust; then there would be some fun. There could be no doubt, however, as to the importance of the subject. India's first need was to increase the standard of living and the wealth of her people, and that could only be done by the development of her glorious resources, which depended upon the development of her railways and ports. He could only say on one political subject that the suggestion that there should be a Central Department dealing with ports, railways, roads so far as they were not provincial, docks, posts and telegraphs, and civil aviation, had already been put forward in connection with the reform scheme and the reallotment of the functions of the Governments in India. That was now under consideration, and, particularly after what the author had said that afternoon, it seemed to him that a strong *primâ facie* case for such an organisation had been made out, and he hoped its consideration would not take long.

SIR CHARLES C. MCLEOD began his remarks by congratulating the Society on having induced the Secretary of State for India to be present at the meeting. With his many duties it must be difficult for him to go through all the literature that was sent to him, and it was quite possible that if he had not been present at the meeting the very important subject under discussion might have escaped his notice. He (the speaker) intended to confine his remarks entirely to the port of Calcutta. The author's assertions with reference to that port were of a very sweeping character, but he did not think they were too strong. At the annual meetings of the Bengal Chamber of Commerce in 1913 and 1914 he referred to the question at considerable length, and the statements he then made generally supported the attitude that had been taken up by the author. He desired to confirm the statement made in the paper that any delay at Bombay involved more than a corresponding delay in the delivery of the mail in this country. A three hours' delay at Bombay of the steamer on which he recently travelled had the effect that the delivery of the mails in London was forty-eight hours' late. While the facilities of the port of Calcutta had been considerably increased it must be borne in mind that at the present moment every warehouse in Calcutta was full up, because there were no steamers to carry away the products. The war was partly responsible for the condition of affairs that existed, but the fact remained that Calcutta at the present time could not handle her traffic. The author had struck a very sound note in advocating that the conduct of a port should be under the control of a smaller number of people than was the case at present, and he brought that into very strong relief when he compared the excellent condition of affairs at Montreal, with only three people to look after the port, with the congested state of Calcutta, with sixteen people in charge. One of the strongest points that must be borne in mind in connection with the ports of India was the fact that the trade eastward went mostly through the Suez Canal, which had been widened and deepened out of all recognition, so that it was now possible for ships of 18,000 tons to go through it. At the present time there was only one port in India, namely, Bombay, which could, at any state of the tide, accommodate a ship of that size. It was certainly necessary that in a few years' time all the principal ports of India should be able to accommodate steamers up to 15,000 tons, which they were quite incapable, in many instances, of

doing at present. Although the author was very severe in his strictures on the administration of Indian ports, he did not only destructively criticise but he put forward suggestions for better administration in the future. For instance, he made the suggestion that there should be a deep, well-buoyed and well-lighted channel extending from the sea to the entrance to docks or wharves. That was what would have to be done if the ports of India were to deal with the great increase in export trade which must come about in the near future.

Sir Charles H. Armstrong said he had been asked to speak on behalf of Bombay. His qualifications for doing so were that he was a Port Trustee for ten years, from 1904 to 1914, and it was during those years that the Alexandra Dock was planned and built. When he left Bombay in May, 1914, he sailed out of the new dock in one of the first large vessels to pass through the dock channel. He had also just returned from a visit to India, so that he possessed a certain amount of up-to-date knowledge. The suggestions the author made for improving the existing state of affairs ought to receive very careful consideration. He accepted with pleasure and without comment the author's statement that Bombay was the premier port of India. The Bombay Trust had always had a definite policy since its formation in 1873, and the author had particularly praised the engineers who had carried out the various developments of the Bombay harbour and docks. He desired to couple with those praises the Chairmen of the Ports, who in most instances had been engineers. Bombay had been very fortunate in having had a series of very able Chairmen, and he could only say that the working of the Bombay Port Trust had given the very greatest satisfaction to the commercial community. The author had suggested that the new dock should be built either alongside the Alexandra Dock or to the north of the Island near Trombay. He was inclined to agree that a new dock alongside the present docks would be inadvisable, because it would be very difficult to handle on shore the large additional traffic that would have to be moved, and it would be impossible satisfactorily to house the large number of additional labourers that would be required. The housing position in Bombay was very acute at the present time. Development work was proceeding to the north of the Island and he hoped that in a year or two, the position would be to some extent relieved. He was very glad shortly before leaving Bombay to hear of the decision which had been arrived at that no new industries should be allowed on the Island of Bombay, and that every inducement would be given to the present industries to go outside the Island. If therefore the new dock was built somewhere near Trombay it would be in close connection with the new industrial area which must arise in the near future, and it would also be very conveniently situated for railway connection with the Great Indian Peninsula and the Bombay and Baroda Railways. He was glad the author had called attention to the insufficient dredging of the Bombay harbour and its approaches. The work of dredging ought to be taken in hand at once, and, as the author stated, the mud that was raised could be used in connection with the reclamations that were now being planned. Under the heading of "Defects in Port Administration" he was surprised to find the author stated that the Europeans on the Trusts, who were often on the verge of retirement, did not as a rule take any interest in the development of the port. The author's experience might have been unfortunate, because his own experience in Bombay was directly the contrary. He expressed no opinion as to whether the Chairman of an Indian Port Trust should be a Royal Engineer, a civil servant, or an engineer of the Public Works Department. In Bombay they had had as Chairmen a succession of engineers of the Public Works Department, and they had done extremely good work. What was required in the chairman of a big port trust in India was a man of great administrative power, with big ideas and far-seeing views, and in the past they had been able to find such men for the Bombay Port Trust. The author would evidently like the chairmen of port trusts to be men sent out from home. In some cases that might be an advantage, because very experienced men could be obtained in this country, but it must be borne in mind that experienced men sent out from England would not be in their first youth. They would not know the port nor understand the trend of Indian trade, neither would they understand Indian customs, so that on many occasions they might work for a considerable time at a disadvantage. Under the heading of "Proposals for Improvement in Administration" the author suggested that a Department of Communications should be established under the Government of India, but personally he thought that unless it was a body of exceptional ability, with men of the very highest standing, it might on many occasions hamper a first-class progressive Port Trust like Bombay. He felt sure that Bombay did not wish to be controlled by any superior body unless it was a body of the very highest class of experts. The author further suggested that capital expenditure for the ports should be provided by the Government of India, which could raise the necessary money in their annual loans and lend it to the Port Trust at a higher rate of interest. That might benefit the smaller ports, but the large ports, Bombay in particular, had the confidence of the public. Bombay could raise any amount of money that it required in the open market at a very moderate rate of interest. The Bombay Trust worked under a system of sinking funds, and its whole system of finance was eminently satisfactory. He would very much regret therefore if the Bombay Port Trust had to rely upon the Government of India for its finance, because the Government of India was

limited in the amount that it could raise. Bombay at the present time was absolutely overloaded with money, which was seeking investment in works of public utility, and it was a very great pity that that money could not be utilised for the extension of the railways. He had received a letter from a prominent member of the Government of India, informing him that that question would shortly come under consideration, and he sincerely hoped it would. A great many very important capital railway works had been held up during the war owing to the want of funds, and he felt sure that they would continue to be held up for a very long time if they had to rely upon the Government to supply the necessary funds. He hoped therefore that before very long it would be possible for the railways to borrow in the open market and that their development would thereby be helped.

Sir Harvey Adamson, K.C.S.I., said he thought that all who heard the paper, whether they agreed or not with all the views which Sir George had expressed, must recognise that it was a very thoughtful paper, written by one who was a master of port administration in all its aspects. He (Sir Harvey Adamson) had been asked to say something of the Port of Rangoon—from his experience as a Lieutenant-Governor of Burma. Sir George Buchanan administered the Port with great success from 1901 to 1915. When he came to Rangoon the port was far behind the times, and very imperfectly provided with equipment for handling the large and yearly increasing traffic. The port was then administered by a body of commissioners nominated by Government, who had no real power or authority, and could scarcely commit themselves to the smallest administrative or executive act without the previous sanction of the local Government. Sir George's first task was to draft a new Act, which came into operation in 1905, and which gave the Commissioners greatly enhanced powers, though perhaps not quite so great as its author desired. With the help of this Act Sir George was able to push ahead with his schemes for remodelling the port. From 1905 onwards a large amount of money was expended on wharves, godowns, pontoons, warehouses, dredgers, and all the paraphernalia of a port, with the result that Sir George had left behind him a port which was in many respects more up to date than any other port in India. During these fifteen years the registered tonnage of shipping had doubled, the value of trade had trebled, and the revenue of the port had quadrupled. The value of Sir George's work might be gauged from the fact that the port was now easily able to cope with the enormously increased volume of trade that was indicated by these figures. It was not only as an Administrator of the Port that Rangoon was indebted to Sir George Buchanan. Rangoon had for long been threatened by the action of a river two miles broad, which was gradually changing its course, with the inevitable result that eventually the town and port would have been left high and dry, stranded far from the natural estuary of commerce. To avert this catastrophe Sir George designed a scheme which was known as the Seikgyi training wall. It was a great work, and was estimated to cost a million pounds. Sir George carried his design, in spite of a great deal of delay and opposition by Simla experts, with the result that the work was completed within the estimated cost and its stability and success had been established beyond doubt. Now might he venture on a little criticism? Sir George put forward as the best solution of the difficulties of port administration the creation of a Department of Communications to deal with railways, inland waterways and ports, roads being left to the local governments. The object of this proposal was that the policy of ports might be guided in the interest of the Empire. That was a reason that sounded very wise, but if it was examined he thought it would be found to be meaningless. The interest of the Empire in the ports of India was simply and solely that each port should be administered so as to provide for the trade that now passed through it, or that might be expected in the near future to pass through it. It was in nearly all its aspects a local matter. Suppose there had been in existence an Imperial Department to guide the policy of the Port of Rangoon in the interest of the Empire, what more could this department have done in past years than Sir George himself had already done for the Port of Rangoon? Then, again, Sir George proposed that ports should be financed by Government including in their loans the sums required for port development. The existing method was that ports borrowed money in the open market on the security of their revenues. Sir George deprecated the new department bearing any resemblance to the Railway Board, but it seemed to him that it would be the same thing over again. His experience of the Railway Board, gathered from Burma, was that, however promising a railway scheme might be as regards its future prospects, if there was no promise of immediate revenue it was hopeless to get the money to carry it out, because there were sure to be other competing schemes in other parts of India which absorbed all the money available for loan. If the local Government had had the power, which the Port Commissioners had at present, of borrowing in the open market on the security of its revenues, he was sure that Burma would now have twice its existing mileage of railways. He deprecated any such scheme of further centralisation. Especially under the new order of things, when the Government of India would year by year be more Indianised, it would be disastrous to Burma to remove the ports from the control of the local Government and place them under an Imperial department. The ports of a province should continue to be under the control of the Government of the province, which was more directly concerned in their welfare, with less interference than at present from the Imperial

Government. If Sir George's Imperial Department had been in existence in the past, he doubted whether Rangoon would have had the up-to-date port which it now possessed, and he fancied that the estimates of the Seikgyi training wall would still be reposing in the pigeon holes of the Department of Communications.

SIR M. VISVESVARAYA, K.C.I.E., M.Inst.C.E. (ex-Dewan of Mysore), said that in India, as in other countries, it was essential that production should be increased by every means in their power, and the measures most necessary for that purpose were the development of scientific agriculture, irrigation, factory industries, mining, etc. In the sphere of transportation, ports and shipping occupied a similar important position. India was bounded on the north, north-east, and north-west by natural barriers, which had not been pierced or crossed by railways as yet. There was no likelihood of communications being opened in those directions for some considerable time to come, and it might be said that so far as communications with foreign countries went, India was practically an island. Unless ports and shipping facilities were sufficient and efficient, the transit charges for commodities would mount very high, and that was actually happening in India. As a result, foreign intercourse was rendered difficult and the Indian farmer did not get the full benefit of the prices realised in foreign markets for his produce. The trade of India had also suffered in the recent war on account of insufficient port and shipping facilities. The foreign trade of Canada, which had only a population of eight millions, recently exceeded that of India with a population of 315 millions. For those reasons he was in favour of improving existing ports and of opening up more ports. Before he left India, he took some interest in the development of a port at Bhatkal, a small town on the west coast about half-way between Bombay and Cape Comorin. Bhatkal was a port of some importance in the last century, but, on account of territorial rearrangements, it lost that importance, and a forest had grown up cutting off communication between Bhatkal and Mysore. The port was situated at the meeting-point of three territorial divisions, the Presidencies of Bombay and Madras and the Native State of Mysore. The Mysore Government was building railways in that direction, and when these were completed only a link of thirty or forty miles would remain to connect the system with Bhatkal. Several rough schemes for developing the port had been prepared, and one of them had lately been approved by a well-known London firm of harbour engineers. A concession from the Government of India asked for by Mysore, namely, political jurisdiction over some three square miles of land near Bhatkal was required to enable Mysore to construct the railway line and the port. It was hoped that under the new order of things in India it would be possible to make this small concession without which the State would not be able to invest the large sum of money required to promote the scheme. While they were considering port facilities, the importance of shipbuilding should not be lost sight of. As a result of the war, many countries, including the self-governing Dominions within the British Empire, which formerly had no ships of their own, were actively engaged in shipbuilding. They had come round to the view that foreign shipping could not be depended upon in emergencies. It was to be hoped that India would take the same view of her responsibilities. Canada had recently started shipbuilding through Government agency, and had schemes of port development in hand estimated to cost about 50 million dollars. Even Australia, with a population of only five millions, was operating a Government-owned steamship line. The United States Board of Shipping constructed ships and sold them to the public. He thought that there should be three classes of ports in India, namely, Imperial, Provincial and local. The minor ports might be developed by the municipalities or other local authorities concerned, with the aid of grants from Imperial or Provincial funds according to circumstances. It was also necessary to associate shipbuilding with port development under Government auspices for some time at the commencement. If such a policy were adopted, he was sure it would strengthen the economic position of India.

MR. H. S. LAWRENCE, C.S.I., I.C.S. (Commissioner in Sind), said that in regard to Karachi Sir George Buchanan had stated that the financial position was insecure; and he based that view on the fact that the expenditure almost equalled the revenue. Surely it was a first principle of correct budgeting to levy no more taxes from the public than were required to balance expenditure; and every port should be as cheap as possible so long as it met its expenditure. Moreover, Sir George quoted figures which showed that the debt of Karachi was equal to only four years' revenue; while in another paragraph they found that the debt of all ports in India was equal to eight years' revenue. And again while Calcutta and other ports had levied special war taxation, Karachi had levied none. He (Mr. Lawrence) submitted that it was clear that this charge of financial insecurity was based on a misapprehension. Sir George also said that Karachi could not challenge Bombay as a port for passengers and mails, because it did not possess the "amenities" of Bombay. If by "amenities" was to be understood climate, there were few persons with an experience of both cities who would prefer the climate of Bombay to that of Karachi. But if they were to interpret that word as covering hotels and entertainments, it was natural to expect that the supply would not precede the demand. Sir George had described the immense variety of interests with which port authorities were brought in contact. There were not only the shipowners and the merchants who called for despatch and safety in the handling of ships and cargoes; there were also

the military, naval, and railway authorities; there were the passengers and mails; and behind all the governing consideration must always be the welfare of the country served by the port. There were two important omissions: the care of dock labour and the welfare of seamen. Dock labour, with its casual employment now the subject of special inquiry at home, would soon be demanding attention in India. During the war they were on the verge of dock strikes in Karachi more than once. The seamen, both Indian and European, had an indefeasible claim to better consideration than they had yet received. Their interests had been left largely to private charity, and the law which authorised Port Trusts to utilise their funds for their benefit had been almost forgotten. The gratitude of the Empire for the heroism of the Mercantile Marine had been expressed in words over and over again. It was time that the port authorities were urged to make good this gratitude by adequate provision for the comfort and entertainment of these splendid fellows. No better War Memorial for Seamen could be devised. To discharge these numerous responsibilities the Chief Executive authority of a port must bring into harmonious co-operation men who approached the complex problems of daily administration from widely varying standpoints; and he was frequently confronted with a serious conflict of powerful interests. Under his control there were many branches, each with a competent professional head; a naval branch dealing with sea captains and pilots, a port engineer for hydraulics and tidal questions, a dock engineer, a mechanical engineer, a railway engineer, and secretaries for trade and commerce. It was clearly impossible to find a man for this supreme control who could be an expert in all these branches. When Sir George expressed his opinion that a Chairman who was not an expert was in the hands of his Board, and was apt to vote with the most insistent mercantile representatives, he felt bound to state that this criticism did not accord with his experience. While he concurred with the main conclusion of Sir George's paper, time permitted him only to record these items of dissent.

Mr. Ernest Benedict, M.Inst.C.E., desired, as the engineer who had charge of the railway works in Karachi forty years ago, to state that the present two miles of wharf, which enable transports to come alongside and discharge troops, ammunition and goods, just across the wharf into trains, were the development of a wharf 700 ft. long which he put up in 1882 at Keamari. The author was accustomed to carry out things on a big scale, and he was therefore astonished at his deprecating a big scheme for the future development of Karachi, which he himself had adumbrated in the paper as the leading port of India. It did not follow that, because a scheme was big, all of it need be carried out at once; in fact, the present wharves had been added to by degrees. The author had made a great point of the building of elevators. He believed an elevator had been built at Lyallpur in the very centre of the wheat district, but he had never heard anything of its working or whether it was a success or not. From what he knew of the Karachi trade, he was afraid it would be impossible to get the local interests to use an elevator, even if it were there, nor did he see how that would give sufficient additional shipping accommodation, although it might release wagons. If the wharves were filled with ships and another one came in, how would the elevator help to solve the problem? He had never heard of a complaint that ships were detained at Karachi, whereas as a matter of fact the facilities were greater, both for passengers and for goods, than they were at any other port in India, and had been so for years past.

Sir Horace Charles Mules, C.S.I., M.V.O., O.B.E., said that he feared he must plead guilty to being one of the unfortunate individuals at whom Sir George Buchanan had had a rap—a so-called inexpert Chairman, but having served for fifteen years as Chairman of the Port Trust at Karachi, he thought he might be permitted to say that he had a little knowledge of port administration. With regard to the author's remarks on the constitution of Port Trusts, he desired emphatically to say that during his chairmanship of the Karachi Port Trust he had found the mercantile representatives on the Board of the very greatest possible value; in fact, he considered it would be extremely difficult, if not impossible, to carry on the Port Trusts in India without the valuable advice and assistance received from the mercantile community, in whose hands lay the conduct of the whole of the trade which passed in and out of the port. Mr. Lawrence had confuted Sir George Buchanan with reference to the financial position of the Karachi Port Trust, but he would add that since the Trust was constituted they had never borrowed a rupee from Government, that in the first year of the present century the revenue of the Karachi Port Trust was under 8 lakhs of rupees, while in the last year before the war it was 58 lakhs of rupees, and the Reserve Fund had risen from less than a lakh to between thirty and forty lakhs. The policy adopted at the Port of Karachi had been a steady development of the wharfage, and that policy was still being continued. In regard to the author's statement that it was ill-advised on the part of the Karachi Port Trust to proceed with the construction of extensive wharfage, he desired to point out that the great scheme of reclamation now in progress contemplated in the first instance merely the creation of six additional berths for steamers of the largest possible tonnage likely to enter Indian ports and drawing the greatest possible depth of water. He did not think a port which at present enjoyed the possession of only nineteen berths alongside the wharf, one of which was a very small one, could be said to be hurrying to perdition when it was going to con-

struct as a preliminary another six berths. They had also not lost sight of the necessity which might arise in the future for the construction of elevators, but they had for the last ten years persistently pursued the policy of following the trade. Years ago the Government of the Punjab, as an experimental measure, constructed a small elevator at Lyallpur, and the late Lieutenant-Governor of the Punjab, Sir Michael O'Dwyer, wrote to the Karachi Port Trust, and asked if they would construct a terminal elevator for that port. In reply they said they were perfectly ready to meet the demands of trade, provided all were prepared to do their part, and they therefore asked the Governments of the Punjab, Sind, and the United Provinces, whether they were prepared to build the necessary elevators along the railway lines which would feed the terminal elevator. They were met by a "non-possumus." He had gone very carefully into the question of the cost, and found that the pre-war cost of an elevator was £3 10*s*. a ton. Karachi, a seasonal port, dispatched in the course of three months about 1,000,000 tons of wheat and other grains, and if an elevator was erected it must have a capacity of at least 300,000 tons. The present cost of building such an elevator would be absolutely prohibitive, and would throw an additional burden not only on the wheat-growing trade, but also on the wheat-consuming public, which it could not by any possibility bear. At the present time labour in Karachi was sufficiently cheap to render it unnecessary to construct elevators, but the Port Trust had never opposed their construction for one moment, and had always recorded their readiness to construct them when the demand arose. The present system, which had recently been submitted to a recognised expert, would provide for the accommodation of steamers of the largest size, drawing the greatest amount of water, that would be used in Eastern waters. He thought the results achieved, financial and otherwise, at the port of Karachi entitled it to its place as one of the foremost and most go ahead ports of India, and that the Board as at present constituted might be thoroughly trusted to carry out their work to a satisfactory conclusion.

Sir Charles S. Bayley, G.C.I.E., K.C.S.I., Chairman of the Indian Section Committee, desired on behalf of the Society to express its thanks to the Secretary of State for his kindness in attending and presiding over the meeting. The subject of the paper was one of very great importance, and the fact that the Secretary of State had recognised this by his presence had been immensely appreciated. He also desired to move a hearty vote of thanks to the author for his exceedingly interesting and valuable paper, which had provoked an equally interesting and valuable discussion.

Sir Krishna Gupta, K.C.S.I., in seconding the motion, said that everyone present knew what a great interest the Secretary of State took in all matters that concerned India, and his presence that afternoon was an additional testimony to that fact. With regard to the author's interesting and suggestive paper, he happened to come from Calcutta, which apparently had fallen on very evil times. Not many years ago it was the capital of British India, but it had now been dethroned from that exalted position. Calcutta had some little pride left in thinking that it was a great port and commercial city, but after what the author had said it was necessary to speak of it with bowed heads. Sir George Buchanan had told them that the inefficient administration of ports in India was due to the fact that they were generally in the hands of men who had only a fleeting interest in their welfare; they were about to retire and were therefore not interested in the permanent progress of the ports. He was not present to sustain or deny the charge, but in view of the reform scheme and its further development it was to be hoped that Indians who had a permanent interest in the development and progress of their ports would have an opportunity of taking a greater interest in them in the future. The pioneers, the British merchants and others, had done a great deal to develop the resources of India, but their interests were not permanent, and if they were associated with Indians who had a permanent and abiding interest in all that concerned India he thought the very best results might be hoped for.

The resolution of thanks was carried unanimously.

Sir George Buchanan expressed his thanks for the appreciation of his paper, and for the patience with which the audience had listened to it. He would take the opportunity of replying to the criticisms that had been made by means of a written communication to the *Journal*. It was with a certain amount of relief that he found that the "full-blooded and lusty Port Trustee from Calcutta" was not present.

The Chairman said he regarded it as one of the first duties of the Secretary of State to go to all meetings where Indian affairs were being intelligently discussed, in order to obtain new opportunities of serving and new material with which to serve. His only difficulty was that unfortunately time did not permit of a more general fulfilment of this duty.

The meeting then terminated.

Sir George Buchanan, in a written reply to the remarks of the various gentlemen who took part in the discussion, says with reference to Sir Charles Armstrong's comments, it was far from his intention to belittle the value of European representatives on the Port Trusts, that in commenting on the difficulties of an Indian Port Trust he had remarked on the constant changes of personnel, and said that Europeans on the

verge of retirement did not wish to be troubled with schemes which would not materialise until after they had left the country. He did not think that was unnatural, the point being that there were many more retirements in India than in the United Kingdom. He agreed with Sir Charles Armstrong that what was wanted as Chairman of a Port Trust was a man of great administrative power, with big ideas and far-seeing views, but it was not correct that he thought it essential that such men should be sent out from home. He would like to see the Indian Port Trusts so well and strongly staffed that there would always be an officer at one or other of the ports capable of taking the Chairmanship at any port when a vacancy occurred, and thus avoid bringing in outsiders, either from India, often with no port experience, or from home, often with no Indian experience. With reference to the comments of Mr. Lawrence, Mr. Benedict and Sir Charles Mules, on the subject of Karachi, Sir George Buchanan would be the last person to deprecate big development schemes; all he suggests is, that before committing themselves to a big scheme, the Port Trustees should satisfy themselves and the public that it is the best possible project. There is no doubt that Karachi cannot for ever remain the only large grain export port which works without an elevator, and he does not accept without data Sir Charles Mules's estimate of the lowest capacity an elevator should have, to be of any use. Labour will not always be cheap, and the desirability of retaining as a permanency the present system of shipping and landing goods is open to question from various points of view. In the matter of finance, it was the Port Trustees themselves who considered a revenue of 50 lakhs a safe average to depend upon for the next ten years, and if that is the case, it is obvious that with an expenditure varying from 45 to 52 lakhs of rupees there is not much margin to pay interest and sinking fund on a 250 lakh loan. Judging from his own experience he thinks the Trustees are possibly not allowing sufficient margin for the increase of trade. Finally, he wishes to say that he is a great admirer of Karachi, and a believer in its future, but, as already stated, he is of opinion that the whole future of Karachi requires the deepest consideration from the Imperial point of view, and that the problems connected with its development require careful consideration, and possibly special treatment. In reply to the criticisms of Sir Harvey Adamson and others on the proposed Imperial Department to deal with Railways and Ports, he would emphasize the fact that the Government of India and the local governments at present exercise very considerable control without the necessary expert advice to guide that control. His proposal is to retain the Port Trusts and to increase their powers, and to strengthen both their hands and those of the Government of India by the creation of a Department which would encourage port development and exercise an efficient and fatherly guidance. Although it is true that Bombay and some of the other ports have done very well under the existing regime, Calcutta and Chittagong have done very badly, and it would be one of the duties of the new department to keep ports up to the mark and up to date, and where ports in the public interest required development but had no immediate funds, the new department would provide funds by other means than handing over the port to a railway company and allocating funds from the Railway Budget. Further, in the case of a badly managed municipality the Government at times found it necessary to step in and insist on reform, and if this is desirable in the case of a municipality it is much more so in the case of a port. In conclusion, Sir George Buchanan regrets if he has by his remarks offended anyone's susceptibilities. As Chairman for many years of an Indian Port Trust he fully realises their difficulties and the zeal and enthusiasm shown by the staffs at the various ports. Improvement is however possible in every undertaking, and he hopes that his paper will be taken as an honest endeavour to assist in the development of Indian ports by suggesting problems for solution.

Mr. W. J. Good, in reply to that portion of Sir George Buchanan's paper dealing with the Port of Calcutta during the period 1900–14, in which he states "Calcutta remained with folded hands, and was only awakened from its sleep . . . ," writes:—

I think that I cannot do better than give a few quotations from the Report of the Committee which sat in 1914, to which Sir George Buchanan refers, and of which the then President of the Institute of Civil Engineers, Mr. A. G. Lyster, was a member. " . . . they (*i.e.* the Port Commissioners) submitted to Government a scheme based on the principle that all future requirements of the trade of the Port should be provided for as near as possible to Calcutta, the centre of a very considerable proportion of that trade. It comprised the acquisition of land adjacent to the existing docks for the gradual construction, as the demand arose, of a new dock system with independent entrances, riverside berths on the available frontage at Garden Reach, and the provision of improved and extended facilities for the reception, distribution, and despatch of rail-borne traffic. The proposals of the Commissioners were approved by the local Government; the administrative sanction of the Government of India was received, and an area of some 5,500 bighas has been acquired. In the meantime the accommodation of the Port has not stood still pending the inception of this larger scheme of extensions. Apart from the improvements at the jetties, which we have already described, at the docks four new berths for general produce have been provided, and another similar berth is under construction; while for export of coal one additional berth has been constructed. Concurrently with these extensions the warehousing accommodation for both imports and exports has been

very largely extended, and numerous lesser improvements have been carried out. While these additional berths represent a very substantial increase on the accommodation for shipping available in 1906, an increase in the case of the jetties of 50 per cent. and at the docks of 33 per cent. (excluding the coal berths), it is clear that, even with these extensions, the rapid expansion of the trade at Calcutta during recent years has outgrown the accommodation. It is therefore now proposed to enter upon the first portion of the greater project contemplated in the proposals of 1906, namely, the construction of the riverside berths at Garden Reach, the entrance to the new dock system, and the construction of a new dock junction railway yard, including the re-alignment of a portion of the Budge-Budge branch of the Eastern Bengal State Railway. The Commissioners have supplied us with a plan to show the general basis on which they contemplate that future extensions should be made. We are of opinion that the lay-out of the scheme is generally suitable, and that it will ensure an ample margin for the expansion of trade which is likely to take place within any period that can reasonably be foreseen. We recognise that in the past the Port Commissioners have developed their property generally speaking on sound lines, and with a zealous regard to the best interests of the port. We consider that the schemes for future development which have been placed before us are on the whole well calculated to foster that development. The main criticism to which the conduct of the port affairs is open is that the inception of these schemes was delayed until the great increase of trade during the last two years showed only too conclusively how urgently they were required. We further wish to take this opportunity of recognising the eminent services which Sir Frederick Dumayne has rendered to the Port of Calcutta during his tenure of office as Vice-Chairman of the Port Commissioners. Without the substantial improvements which have been effected in every branch of the port administration during his incumbency of the post, the general expansion of trade which has taken place, and the corresponding growth in the revenues of the Port Trust, would not have been possible. The schemes of extension, to which we have just referred, were initiated under his auspices, and that their inception is now possible is due to his foresight and to his grasp of the situation. Had the decision rested with Sir Frederick Dumayne, it is probable matters would by now have been further advanced, but we believe that his anticipations of the future growth of the trade of Calcutta were generally regarded as too optimistic. In the result they have been completely justified."

To summarise, in the period 1900-14 Calcutta, "with folded hands," in addition to the accommodation available in 1900, provided, acquired, or had under construction for the accommodation of the increase in her trade: (*a*) Nine additional berths for ocean-going vessels fully equipped with cranes, etc.; (*b*) 2,400,000 square feet of covered area for handling and storing goods; (*c*) 1,800 *acres* of land for new docks, railway yards, and storage depots; (*d*) two powerful dredgers for the river channels and one for the port. At the same time reductions in charges were made amounting to over 100 lakhs of rupees over the whole period. During the war it was practically impossible to proceed with new works, but the Commissioners have provided two new berths, and hope by the end of 1921 to have four berths for ocean-going vessels and 1,080,000 square feet of covered storage room additional to the accommodation available in 1914. They are also just about to embark on a new dock scheme which will finally give at least forty additional berths. In the preparation of the plans for this scheme the Commissioners' Engineering Staff have had the advantage of consultations with their Consulting Engineer, Mr. J. Angus, and with Lieut.-Colonel Cartwright-Reid on the spot. To other points raised by Sir George Buchanan, I hope to reply fully at another time.

Sir George Buchanan, in reply to the written communication from Mr. W. J. Good, says he did not intend his remarks as to Calcutta remaining with folded arms, and being awakened from its sleep, to be taken so very literally. Of course the port was kept going, and a certain number of works were carried out, but the fact remained that, at the beginning of the war, Calcutta was the only first-class port in India starting a great scheme of extension instead of finishing one. Sir George Buchanan observes that Mr. Good's quotations are really confirmatory of the statements in his paper. For instance, the Committee's remark to the effect that, "the main criticism to which the conduct of the port affairs is open is, that the inception of these schemes was delayed until the great increase of trade during the last two years showed only too conclusively how urgently they were required." Further on, and again quoting from the 1914 Committee report, Mr. Good says, with reference to the delay to carry out works at Calcutta: "Had the decision rested with Sir Frederick Dumayne, it is probable matters would by now have been further advanced, but we believe that his anticipations of the future growth of the trade of Calcutta were generally regarded as too optimistic. In the result they have been completely justified." Sir George Buchanan pointed out the disadvantages of dual control in port administration, and no doubt had it not been for the dual control of Chairman and Vice-Chairman Sir Frederick Dumayne would have carried his point. There was considerable opposition at Bombay to the Alexandra Dock scheme initiated by Sir Walter Hughes, but he as Chairman and Chief Executive Officer combined, was strong enough to frame his policy and carry it through, in spite of opposition, with the result that his great dock scheme was finished and opened by the Viceroy in 1914.

POULTRY AND EGG PRODUCTION IN CHINA.

The poultry and swine industries are by far the largest of the live stock industries in China, the former being the most important. Nearly every family in the villages in all parts of China raises fowls, and many keep one or more brood sows. Professor King, in his interesting book "Farmers of Forty Centuries," states that in Japan there are 16,500,000 fowls, or about one fowl for every three persons in that country. The number of fowls raised to maturity in the United States in 1911 was 300,000,000, or three for every person. There are several varying estimates of the number of fowls in China. Striking a medium between the number in Japan and in the United States, China would have one bird for each inhabitant, or approximately 400,000,000, and, judging from the number of fowls seen everywhere, this is not an overestimate. Further, the Chinese are heavy users of poultry and eggs, and probably consume as much, if not more, per capita than does the average American. Despite the heavy consumption the supply not only keeps up with the demand, but is enough to permit a fairly large export of poultry and poultry products.

According to the Japanese authorities, the average egg production per hen in Shantung is eighty-four, which is high compared with other countries, the average in the United States and Canada being about seventy-five. It is also higher than investigations so far have shown it to be in Canton. In 1918 a production experiment lasting a year was conducted with thirty hens, of the common mixed variety seen everywhere in the villages of that region. They were given the feed commonly fed to fowls by the villagers. The lowest record was fourteen, the highest 104, and the average for all seventy-two. The higher production per hen in Shantung Province is probably due to the feed used in that region, which consists principally of beans, whole and cracked. Beans contain a high percentage of protein and make an excellent food for egg production.

The estimated total value of poultry and eggs produced each year in China is about £84,000,000. As mentioned above, these are not all consumed in the country. In 1917, for instance, shipments of eggs (fresh and preserved) from China totalled 57,987,000 lb. valued at £400,000, and of egg albumen and yolk 54,002,000 lb. valued at £2,590,000. The fresh eggs are exported chiefly to Hong Kong and Japan, and the dried product to Great Britain, Spain, and the United States. Before the war a considerable portion of the dried product went to Germany.

According to a report by the United States Consul at Canton, there are a number of breeds of poultry native to China, some of which have become very popular in America and Europe. The Cochin breed of Swatow, of which there are two varieties in China, the White and the Buff, and the Black Langshan, known in China as the Black Shanghai, are Chinese breeds that are common in most parts of the world where attention is given to poultry production. These are heavy breeds and are raised especially for meat, although they are also good layers of large eggs. The hens weigh from four to six pounds and the cocks from five to nine pounds.

Two other distinct native breeds are the Silkie and the Frizzle. Literature written a thousand years ago mentions these peculiar breeds. These fowls are not very common, the reason given being that they are difficult to raise, and that they are poor layers. Their meat is considered by the Chinese as having medicinal value, and is eaten for a tonic. The skin of the Silkie is dark blue, and a thin, black film surrounds the bone. In both breeds the bill and the exposed skin on the head, feet, and legs are deep blue. The Silkies have downy feathers, white being the most common colour. The Frizzles are black, and have peculiar feathers which curl back on themselves. Their price is usually twice that of ordinary fowls.

Ducks and geese are raised in large numbers in many parts of China. The numerous waterways, both natural and artificial, afford ideal conditions and cheap feeding for these classes of poultry. While there is no recognised breed of ducks in Southern China, the White Peking duck of North China has become established the world over as the best variety of meat duck. It was introduced into England in 1873.

In the region of Canton and most parts of Southern China the common duck is a small dark grey or white and grey bird, weighing from 3 to 5 lb. It is a very good eating duck, and is very popular, used either fresh, roasted, or dried. In the northern part of Kwantung a grey duck weighing from 8 to 12 lb. is found. Ducks of this breed are very good layers and the meat is said to be excellent.

Two of the world's best varieties of geese, the Chinese white and the Chinese brown, have their origin in China. To-day they are found in most parts of China, America and England. The Chinese geese are the most beautiful of all varieties, and are in demand for ornamenting lakes of public and private parks. They are also superior for practical purposes, outrivalling all other breeds and varieties in egg production and in the quality of their meat. Their bodies are plump and round, and they produce a good quality of feathers and down. They are medium in size, mature specimens weighing from 10 to 14 lb.

In general appearance the Chinese geese have long necks, carried very upright, and a large orange-coloured round knob or protuberance on top of the bill at its base. The larger the knob the better. In the south a small grey variety is common. It is not as ornamental as the white and grey species but has meat of good quality. The protuberance on the base of its bill is coloured black.

Some chickens are hatched in the natural way, but by far the greater number are hatched in large incubator shops throughout the country. In the vicinity of Canton there are fifteen Chinese incu-

bators, which hatch an average of 2,800 chickens and ducks a day during the hatching season from March until October. Estimating that half of these grow to maturity, nearly 5,000,000 fowls are supplied each year to Canton and surrounding villages by the incubator shops. The Chinese method of incubating eggs is economical and efficient when it is desired to produce poultry in large numbers, and it is strange that the method has not been adopted for hatching eggs on a commercial scale in other countries.

Wuchow, on the West River, is probably the largest poultry producing centre in the south. The customs returns for the year show that after supplying the local demand, that city exports an average of 2,500,000 birds a year to Macao and Hong Kong. Nanking, Hankow, and Young Kong rank also among the large poultry-producing centres of China.

The methods for applying heat in the Chinese incubators are similar to those used by the Egyptians 4,000 years ago in similar incubators, ruins of which still exist in the Nile River Valley. On the first day the eggs are thoroughly warmed to the proper incubating temperature, of 103° F. or a little less, by placing them in a brick, oven-like room, usually 6 feet deep, 12 feet long, and 10 feet high. The eggs are placed in baskets arranged on shelves around the walls of this room, each basket holding 200 or 300 eggs. In the larger shops as many as forty or fifty of these baskets may be found in this oven at the same time. Heat is furnished by burning charcoal in earthenware pots placed on the floor of the room. Sometimes baskets of eggs are placed in large stone jars and a slow charcoal fire is kept burning continuously against or underneath the outside of the jar. This method is largely used at Shanghai, Hankow, and other places in the north, where the climate is cooler and constant application of heat is necessary through most of the hatching season. Another method used in Honam is to place the eggs on the roof of the shop in warm sunlight until they are thoroughly heated through to the right temperature.

After the eggs have been heated to the proper temperature, either in the oven or in the sun, they are placed in cylindrical baskets about 30 inches deep and 20 inches in diameter. Each basket holds about 1,000 eggs. The walls of the basket are about 1½ in. thick and are made of firmly packed rice-straw held in place with wicker or bamboo both inside and outside. The baskets are lined with a heavy grey paper, somewhat like asbestos. This paper and the basket itself are thoroughly warmed before putting in the eggs, which are arranged in layers, each layer being separated by a piece of cloth about 2 ft. square. Twice a day the eggs are changed from one basket to another. The operator simply grasps the corners of the cloth, and in so doing the eggs naturally tumble together in a heap in the centre. He then transfers it with the eggs to another basket. This method takes the place of the slow method of turning eggs used with modern incubators, and is most efficient, requiring only about one-tenth the time. Transferring the eggs from one basket to another by this method also gives the airing considered necessary for the production of strong healthy chickens.

The eggs are usually kept in the baskets fourteen days, and are then transferred to large trays, 6 ft. wide, 18 ft. long, and 3 in. deep. Each tray holds about 10,000 eggs. The bottom of the tray is lined with the same heavy paper with which the baskets are lined. The eggs are also covered with this paper, with blankets, or with both. The amount of coverings depends, of course, on the weather and the period of incubation. In warm weather no covers are needed during the last two or three days. Just before hatching time, the number of eggs in the trays is reduced to one layer, and an empty space of about two feet is left at one end toward which the eggs are turned or rolled twice a day.

The eggs are candled twice, usually on the third and seventh days, and all infertile eggs are sold, so that there is very little loss through unhatched eggs. Throughout the incubation period careful watch is kept over the temperature. No thermometer is used, but the operator raises the lid or a blanket, removes an egg and presses the large end against a closed eyelid where the skin is very sensitive to temperature. Long practice has taught him to judge differences in temperature quickly and accurately. The men sleep in the room with the eggs, or in adjoining rooms. Someone is on duty constantly, examining and regulating each basket or tray according to its individual needs.

The chickens when hatched are placed in circular bamboo trays about 3 ft. in diameter and 8 in. deep. They are ready for sale as soon as dry. The hatching percentage usually runs about 75 per cent. of the fowl eggs and about 90 per cent. of the duck eggs. This average hatch is quite fair, and, with better sanitation, ventilation, and construction of buildings, and the use of thermometers, this method of hatching eggs on a large scale would be far more economical and efficient than hatching chickens in any of our so-called modern incubators.

In Canton the eggs are usually purchased at two cents (local silver) each and sold at from four to six cents each, the price depending on the demand and the season. The chickens and ducklings are usually contracted for in large lots by chicken dealers and large duck feeders. Large chicken-feeding farms are not common, but there are many duck farms on Honam Island, feeding from 5,000 to 50,000 ducks at one time. These are purchased from the commercial incubators when about a day old in lots up to 40,000, and fed for about 100 days, when they are sold in the Canton markets.

THE PORTUGUESE CORK INDUSTRY.

According to a report made by the Association of Corkwood Manufacturers of Portugal, the total world production of corkwood is estimated at

396,832,000 lb., of which 45 per cent. is produced in Portugal, 30 per cent. in Spain, 5 per cent. in France and Italy, and 20 per cent. in Algeria and Tunis. For the present, writes the United States Consul-General at Lisbon, Portugal is the largest producer of corkwood, and probably will maintain its position for several years more. In some districts of Portugal the quality of the corkwood is superior to that of other countries. The forests in Algeria and Tunis, the exploration of which began recently, may produce larger quantities of corkwood in the future. The same is true of Morocco, whose extensive forests will enable it to become the first producing country of corkwood in the world.

The greater part of corkwood is used in manufacturing cork stoppers and cork discs. Cork waste is employed in making linoleum, for which purpose virgin corkwood is also used.

The principal importers of Portuguese corkwood are: England, which imports ready-made cork stoppers, France, South America, United States, and Germany. They import chiefly corkwood, and the cork stoppers are made in the importing countries. Portugal manufactures 25 to 30 per cent. of its corkwood into cork stoppers; Spain, 70 to 80 per cent.; and France, the whole continental and a small part of colonial production. The small percentage of cork stoppers produced in Portugal is due to lack of modern machinery, and also to heavy duties on this product in the consuming countries.

NOTES ON BOOKS.

THE HARDWOODS OF AUSTRALIA AND THEIR ECONOMICS. By Richard T. Baker. Sydney: William Applegate Gullick, Government Printer.

It is roughly estimated that the number of species of trees growing in Australia is about five hundred, and of these the *genus* Eucalyptus accounts for some two hundred. The Eucalyptus covers an enormous area of the continent—hundreds of thousands of square miles; all the timbers of this family are valued for their hardness and weight, and they are remarkable for the rapidity of their growth. The author quotes the case of an Australian gum tree, which made as much hardwood in twenty-four years as an English oak in two centuries. This is enough to show what enormous potential wealth Australia possesses in her timbers.

The present volume has been designed by the author, who is Curator and Economic Botanist, and Lecturer on Forestry in the University of Sydney, to make known to Australians in particular and to the world in general the qualities of the various hardwoods which flourish on the continent, and is especially written for architects, saw-millers, engineers, cabinet-makers, and foresters. The first part deals with the physical properties of timbers, a particularly interesting section of which is concerned with their comparative combustibility. Now that naval construction, on a large scale, is being undertaken in Australia, it is important to find woods of low combustibility for internal use in ships of war, and Australia is fortunate in having a large supply of such timbers. A list of woods arranged in the order of their fire-resisting qualities will be found exceedingly useful in this connection.

Part II. contains descriptions of the various species of hardwoods in botanical sequence. This occupies 350 pages. A great number of the sections are illustrated with coloured plates which give an excellent idea of the appearance of the various timbers, both as to shade and grain.

Part III. is technological, and deals with the uses of the woods in architecture, engineering and for general purposes. Some space is devoted to the problem of seasoning, both by natural processes and by kiln-drying. Various methods of preserving timber are discussed, and a number of photographs are given illustrating the various uses of timber in building and fitting railway cars, bridges, wharves, jetties, and in the manufacture of furniture. The book has been compiled with much care, and contains a great amount of information, which should go far to popularise the use of Australian timbers.

GENERAL NOTES.

CULTIVATION OF WHEAT IN FRANCE.—A first meeting of the Comité National du Blé has recently been held in Paris, under the auspices of the Minister of Agriculture. It was decided to take immediate steps to impress upon the farmers, and the rural population generally, the necessity of immediate action respecting the production of wheat in France. It is proposed in the first place to collect all available data on the subject, and to disseminate it amongst the farmers and agricultural population generally, and to organise local and departmental competitions throughout the country. It is estimated that at the present time the total area under wheat cultivation in France does not exceed 4,800,000 hectares, or say 11,816,000 English acres, as compared with 5½ to 6½ million hectares (13,545,000 acres to 15,735,000 acres) under wheat before the war. This gives an average yield of 12 quintals per hectare (4·86 quintals or 18 bushels per acre). It would be necessary to increase this to at least 15 to 16 quintals per hectare, in order to approximate the average yield obtained in other countries. Such results might be obtained by a better system of tillage, the use of manures and selection of grain for sowing, in fact, by the best known methods of cultivation.

CARBORUNDUM.—Corundum is an extremely hard mineral used for polishing, and among the coloured varieties are the precious gems, sapphire, oriental ruby, topaz, emerald, and amethyst. Carborundum is an abrasure, and, with the possible exception of the diamond, is the hardest substance known. It is made of carbon and silicon combined by reduc-

tion in an electric furnace, the two thus fused and united becoming an entirely new compound, with new properties. This new abrasion is produced as a crystal of great hardness and is put on the market in the shape of grains and powders; made into wheels for grinding and polishing, formed into cutters for smoothing pottery and porcelain; shaped into bricks and blocks for dressing and smoothing marbles, and fashioned into more delicate instruments for the use of lapidaries, dentists, etc. The manufacture of carborundum requires enormous heat—6000° to 7000°, which can only be obtained in the electric furnace. The corundum plant, the only one of the kind in the world, stands on the banks of the Niagara River, a close neighbour to the great stone building where the Niagara power is generated and from which it obtains the force which it uses to fuse the new compound. Corundum is plentiful in India, Ceylon and Burma, and is related to the diamond, for the diamond is produced by a combination of great heat and pressure. The great heat is already an accomplished fact; possibly in the near future the great pressure may also be obtainable.

PUBLIC AIR SERVICE BETWEEN NICE AND NIMES.—A regular service by the air route between Nice and Nimes has lately been established by the Compagnie Aerienne Française. The service, for the present between the two places, is bi-weekly. Leaving Nice and Nimes on Mondays and Thursdays at 7.30 a.m. and 3.30 p.m., the journey is accomplished, including a stoppage at Avignon, in two hours. Four avions of the A.R. type, of 200 h.p. each, are at present employed for this service.

MEETINGS OF THE SOCIETY.

INDIAN SECTION.

Friday afternoon, at 4.30 p.m.:—

JUNE 18.—SIR VALENTINE CHIROL, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.) The RIGHT HON. LORD MESTON, K.C.S.I., LL.D., will preside.

CANTOR LECTURE.

Monday evening, June 7th, at 8 p.m. (lecture postponed from April 26th):—

WALTER ROSENHAIN, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy, National Physical Laboratory, "Aluminium and its Alloys." (Lecture III.)

Syllabus.

Special Uses of aluminium alloys—Castings for automobile and aeroplane parts—Castings for aero-engines—Pistons and piston alloys—Properties at high temperatures—Automobile and aero-cylinders—Other engine parts—Structural uses—Rigid airships, aeroplane spars, and wing-coverings—Possible future developments.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, MAY 31 ... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian Section.) Mr. A. Howard, "The Improvement of Crop Production in India."

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. Rev. J. A. McDowall, "The Meaning of the Aesthetic Impulse."

Farmers' Club, Central Hall, Westminster, S.W., 4 p.m. Dr. E. J. Russell, "Farmyard Manure: its Making and Use."

TUESDAY, JUNE 1...London Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m.

Anglo-Russian Literary Society, Imperial Institute, South Kensington, S.W., 3 p.m. Mr. A. White, "England's Bounden Duty and Gratitude to Russia."

Royal Institution, Albemarle-street, W., 3 p.m. Major C. E. Inglis, "The Evolution of Large Bridge Construction." (Lecture II.)

Alpine Club, 23, Savile-row, W., 8.30 p.m.

Anthropological Institute, 50, Great Russell-street, W.C., 8.15 p.m. Dr. B. Malinowski, "The Economic Pursuits of the Trobriand Islands."

Zoological Society, Regent's-park, N.W., 5.30 p.m. 1. Dr. G. M. Vevers, "Report on the Entozoa collected from animals which died in the Gardens during the past nine months." 2. Professor R. T. Leiper, "Exhibition: Experimental transmission of some Helminth infections." 3. Dr. W. T. Calman, "Notes on Marine Wood-boring Animals.—I. The Shipworms (*Teredinidæ*)." 4. The Secretary, "Notes on an African Trip."

WEDNESDAY, JUNE 2...Royal Archæological Institute, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Professor F. M. Simpson, "Santa Sophia and the Mosques at Constantinople and Brusa."

Public Analysts, Society of, at the Chemical Society, Burlington House, Piccadilly, W., 8 p.m. 1. Mr. H. D. Richmond, "The Estimation of Nitroglycerine." 2. Mr. R. L. Morris, "The Perchlorate Method for Potash." 3. Mr. E. R. Dovey, (*a*) "Apparatus for Evolution Methods of Analysis"; (*b*) "An Improved Form of U-Tube."

THURSDAY, JUNE 3...Royal Society, Burlington House, W., 4.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. 1. Mr. R. Swainson-Hall, "Exhibition of Fifty drawings of the Oil-palm, *Elæis guineensis*." 2. Mr. A. Whitehead, "Objects observed in the Neighbourhood of Basra, during the War." 3. Professor W. J. Dakin, "Whaling in the Southern Ocean."

Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. M. O. Forster and W. B. Saville, "Studies in the camphane series.—Part XXXVIII. The cyanohydrazone of camphorquinone." 2. Mr. R. G. Fargher, "Arsinic acids derived from guaiacol and veratrole." 3. Messrs. G. T. Morgan and D. C. Vining, "Diphenylarsenious chloride and cyanide. (Diphenylchloroarsine and diphenylcyanoarsine)." 4. Messrs. F. Challenger and A. E. Goddard, "Organo-derivatives of bismuth.—Part III. The preparation of derivatives of quinquevalent bismuth." 5. Mr. J. N. Ray, "Modification and extension of Friedel-Crafts' reation.—Part I." 6. Mr. F. Arnall, "The determination of the relative strengths of some nitrogen bases of the aromatic series and of some alkaloids." 7. Mr. J. C. Ghosh, "The electrical conductivity of pure salts in the solid and fused states: determination of the activity coefficients of ions in solid salts." 8. Messrs. W. J. Sanderson and W. J. Jones, "Anethole as solvent in the cryoscopic method of determining molecular weight."

Royal Institution, Albemarle-street, W., 3 p.m. Mr. W. Archer, "Dreams, with special reference to Psycho-Analysis." (Lecture II.)

University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Dr. W. M. McGovern, "The Philosophy of Japanese Buddhism."

FRIDAY, JUNE 4...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. (Indian and Colonial Sections.) Sir John Cadman, "The Oil Resources of the British Empire."

Royal Institution, Albemarle-street, W., 9 p.m. Sir Ronald Ross, "Science and Poetry."

Philological Society, University College, W.C., 5.30 p.m. Dr. H. Bradley, "Dictionary Evening."

SATURDAY, JUNE 5...Royal Institution, Albemarle-street, W., 3 p.m. Dr. Y. H. Jeans, "Recent Revolutions in Physical Science—(II.) The Theory of Quanta."

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

MONDAY, JUNE 7th, at 8 p.m. (Cantor Lecture.) WALTER ROSENHAIN, B.A., D.Sc, F.R.S., Superintendent, Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, "Aluminium and its Alloys." (Lecture III.)

Further particulars of the Society's meetings will be found at the end of this number.

INDIAN SECTION.

MONDAY, MAY 31st; SIR ROBERT W. CARLYLE, K.C.S.I., C.I.E., in the chair. A paper on "The Improvement of Crop Production in India," was read by MR. ALBERT HOWARD, C.I.E., M.A., A.R.C.S., F.L.S., Imperial Economic Botanist to the Government of India.

The paper and discussion will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

SEVENTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 21st; LORD LONDONDERRY, K.G., M.V.O., in the chair.

THE CHAIRMAN, in introducing the reader of the paper, said that Air-Commodore Maitland was one of the original pioneers of the flying service. In 1908 he travelled from London to Russia—a distance of 1,117 miles—by air balloon in 31½ hours. He had the misfortune to break both his legs in an accident on Salisbury Plain to an aeroplane that had been built for him, the aeroplane being subsequently bought by the Government and being the first British-built aeroplane, with the exception of Colonel Cody's machine, bought by the War Office of this country. In 1910 Commodore Maitland was posted to a balloon school at Farnborough, and joined the Air Battalion in 1911. On the formation of the Royal Flying Corps he was given the command of the No. 1 Squadron of Airships, and commanded the early Army airships—the "Beta," "Gamma," "Delta" and "Eta." He was transferred with the Army airships to the Navy in 1914, and had been closely connected with their development ever since. His last exploit was to cross and re-cross the Atlantic in the R 34. The record of Commodore Maitland was therefore second to none in the Air Service, and the thanks of the country were due to such men for the Air Service as it existed at the present time, and for the future developments which were certain to be brought about.

The paper read was—

THE COMMERCIAL FUTURE OF AIRSHIPS.

By AIR-COMMODORE E. M. MAITLAND, C.M.G., D.S.O., A.F.C.

INTRODUCTORY REMARKS.

I am very glad indeed to have the opportunity of addressing the Fellows of the Royal Society of Arts this afternoon on "The Commercial Future of the Airship."

A great deal has been said of late both in the press and elsewhere on the many uses to which the aeroplane can be put for commercial purposes, but very little has as yet been said about the airship or lighter-than-air side of aerial development. It is my object therefore this afternoon, in the short time at my disposal, to put before you as briefly as possible some of the undoubted advantages which the airship can claim to possess over the existing forms of transport for commercial purposes.

There is a further reason why I welcome this opportunity. The Royal Society of Arts has always taken the keenest interest in furthering and generally assisting the advancement of every department of science in connection with the Arts, manufactures, and commerce of this country, and the confidence and support of its Fellows will go far in helping on the ultimate progress of both the lighter and heavier-than-air branches of commercial aerial development.

Introduction.

The airship has two distinct uses—service and commercial.

The chief service functions of the airship are, broadly speaking, extended and fast patrol, convoy and scouting duties, for which the rigid and non-rigid airships each have their use.

The commercial function of the airship is rapid long-distance transport, and for this purpose the rigid airship is the more suitable type. It is with the commercial future of the rigid airship that I propose to deal to-day.

A question of great practical importance in the preliminary consideration of airships is the interchangeability between the service and the commercial airship. The airship, although already developed to the stage of great utility both for service and commercial purposes, is not yet highly specialised, and its rapid conversion from one use to the other is a matter of comparative ease. The hull in both types will, for many years to come, be the same, and it is, broadly speaking, merely a matter of replacing the commercial accommodation with bombs, machine-guns, etc., to convert the commercial rigid into a most efficient service airship. This interchangeability is far more marked than in sea-going vessels. The airship of to-day, so far as its adaptability is concerned, should be compared to the sailing vessel of Elizabethan time, ready at her country's need to become a ship of war and capable of as rapid conversion. This question of the interchangeability of the service and commercial airship is of extreme importance, as on it depends the logical and economical method of future development.

The close association between the Navy proper and the mercantile marine has been proved beyond question an unqualified success in the Great War. Many of the auxiliary vessels, from mine-sweepers to auxiliary cruisers, which were previously anything from trawlers to liners, were of extreme war value. There is no doubt that the policy of a Royal Naval Reserve saved the country considerable expense during peace time, by allowing the naval forces in war time rapidly to expand to a strength which would have otherwise have been impossible. An almost exact parallel can be drawn in the case of the airship. The number of surplus air personnel not required in peace, but of vital necessity in the event of war, can be kept economically in training by the existence of a commercial airship service. Economy will be essential in all matters for many years to come, and I hope I have made it quite clear that the necessary reserve of airships and personnel to meet the exigencies of war can be economically provided by a commercial airship fleet.

Development and Effect of Transport and Communication.

Everything in civilisation ultimately depends on transport and communication, which may be termed the machinery of civilisation, and if civilisation is to progress, transport and communication must be developed.

The study of the effect of transport and communication on history is of absorbing interest, both in indicating the line along which they should be developed in the future, and the benefits humanity may expect to obtain. If ancient history is studied from this point of view, the almost mathematical relation between size of empire and ease of transport and communication becomes apparent. Probably, the most outstanding example is that of the Roman Empire, and the gigantic development in road transportation achieved during its existence.

An example of the effect of transport and communication upon history in more recent times is the difference between the effects of the American War of Independence and the Boer War. In the first case, much bloodshed and bitterness of feeling between Great Britain and America resulted, taking over a century to heal. In the second case, twelve years after the fighting ended, South Africa was one of Great Britain's most loyal partners in the World-war.

The two countries America and South Africa are practically equidistant from Great Britain. The statesmen of to-day are presumably no wiser and greater than those of two hundred years ago. I say this with the greatest diffidence. The great factors which have changed are transport and communication. Slow and difficult communications caused misunderstanding. Rapid and easier communications led to understanding and mutual adjustment.

Transport has similarly altered the whole character of war. Wars began as small club or bow-and-arrow affairs between neighbouring villages which, as transport facilities improved, joined themselves into states and countries, thus extending the magnitude of their wars. Almost invariably wars, in the last thousand years, have been waged between countries and not between isolated parts of a country, culminating in the World-war.

Looking into the future, history thus seems

to indicate that as civilisation and the machinery of civilisation—transport and communication—develop, some form of central government will ultimately arise which will control the whole world. At the present time, however, it is true to say that no stable form of central authority, whether it be a League of Nations or anything else, can be maintained unless existing transport and communication facilities are considerably improved.

Limitations of Existing Means of Transport.

Just as in the case of an airship, sea-going vessels increase in performance with increase in size, and it is seen that between the great centres of population, notably between America and Europe, where high speed transport is in great demand, the largest liners are used to meet the exacting requirements of high speed and long distance.

To build a liner with the necessary speed for the Transatlantic service, it is essential to provide a very large hull to carry the powerful engines and large amount of fuel required. Owing to the necessarily very large size of these ships, an enormous number of passengers must be carried, so great a number, in fact, that it is impossible to operate these large liners at a profit anywhere except between the very greatest centres of population. Between centres of lesser population there would not be sufficient demand for the large amount of comparatively expensive accommodation.

This limitation is illustrated in the case of the service between this country and Australia. Recently, owing possibly to the advent of aircraft with their high speed, a determined effort was made by Australia to shorten the time of passage between Australia and this country. Apparently the steamship companies are quite unable to provide any material improvement in this direction, as they point out that to produce such improvement it would be necessary to construct ships of such a size that they would be out of proportion to the volume of traffic.

In the case of airships of the very largest size contemplated, the number of passengers, mails, etc., carried would be so small compared with large liners that they could be run over routes where the traffic would not warrant the use of these very large liners.

It is, therefore, on the main sea routes that the airship will have its great opportunity, and I hope to show later in the paper that it can operate on such routes at commercial prices.

Successful competition between aircraft and existing means of land transport is a much more difficult matter than over sea, owing to the higher speed of land transport; and though ultimately aircraft may compete successfully for the most rapid transport requirements, it is unlikely in the near future that air transport will be a serious rival to the existing forms of land transport in developed countries.

For routes over both land and sea combined, aircraft have a distinct advantage, owing to the time wasted in changing from train to ship. Over this type of route commercial aerial activity was, as we all know, first instituted in the case of the London-Paris and London-Brussels aeroplane passenger and mail services.

The Need for High-speed Transport.

It cannot be too strongly emphasised that the unit in life is time, not distance; and the distance between two countries is in practice measured by time. Out of the six main factors in transport, the claim of aircraft for an assured future is based on speed—that is, reduction in the time taken by transport.

Transport is governed by six essential factors:—(1) safety; (2) regularity; (3) carrying capacity; (4) comfort; (5) speed; (6) cost.

The relative importance of these factors varies according to the special object in view, and even similar goods transported over the same route may require different types of transport.

The state of the existing means of transport is a vital consideration in developing any new form of transport. To compete with the existing forms of land transport, where goods can be conveyed at sixty miles an hour and over (varying with the state of the development of the country), the speed of any new type of transport obviously must be greater than is necessary to compete with sea transport where the present speed is less than half as fast as on land. Trans-shipment from train to surface craft still further reduces the mean speed of existing transport and favours air transport.

Meteorology and the Choice of Airship Routes.

The choice of airship routes depends so very largely on the prevailing weather conditions and position of the permanent winds that the two subjects must be dealt with together.

I would like to emphasise the importance of accurate meteorological information for all forms of aerial transport. Winds of 40 miles per hour will often be encountered. These will

usually be local in area and will vary greatly in force and direction at different heights above the ground, and if accurate meteorological information is available these winds can frequently be used to assist the airship instead of constituting a hindrance. If full use is made of these winds, both in regard to original choice of routes, and in the actual flying over these routes, the speed made good over the ground can be made to exceed the actual air speed. As meteorology and our own flying experience develop, the winds should ultimately become less of an enemy and more of a friend.

Winds may be divided into two classes—permanent winds and variable winds. The permanent winds are the more important in original choice of routes, and consist chiefly of the trade winds and the westerly drifts. Generally speaking, the winds just north or south of the Equator are easterly and the winds near the poles westerly, so that a ship flying east would endeavour to choose a route in latitudes from 15° to 30° north or south, and when flying west in latitudes between 45° and 60°.

In the chart on the screen showing proposed airship routes of the world this tendency is easily seen. Thus, the route from England to Australia crosses the easterly winds practically at right angles, and turns east from the Cape, making use of the permanent southern westerly drift, or "roaring forties." The return journey is made nearer the Equator to use the easterly trade winds or easterly slants. The Atlantic route is similarly dealt with.

There are also many other less important permanent winds and also seasonal winds, which can be made use of, and will slightly modify the routes during different periods of the year.

The variable winds are the winds which are directly due to depressions, and can only be used provided accurate meteorological information is available. The ability to use these variable winds depends largely on the speed of the airship, as the pilot will often find it necessary to push through a narrow belt of strong wind in order to gain the advantage of a favourable wind later.

As mentioned later, electrical storms form a potential danger to all forms of aircraft, but as the area in which such disturbances are prevalent can be very accurately charted, the routes will be chosen so as to avoid these areas and thus reduce this danger to a minimum.

Reliable weather forecasts necessitate a large number of accurate observations being taken over very extended areas, and to run an organisation especially for this purpose would be extremely costly. If, however, arrangements were made for all sea-going ships fitted with wireless, also the various shore wireless and cable stations throughout the world, to take and transmit meteorological readings, it would probably be possible, in time, to organise an adequate meteorological service for little cost, special meteorological stations only being required in a few isolated positions.

Commercial Capabilities of Airships.

Having dealt very briefly with the fundamental aspects of sea routes, land routes, and routes over both sea and land, I now propose to consider the capabilities and limitations of airships with regard to the essential transport requirements.

Safety.—This term must, owing to the nature of all forms of transport, be purely relative. Even in the most "safe" form of transport, there is always some small risk. The airship is definitely the safest method of air transport, and if the statistics are studied for the pre-war commercial airship flying in Germany, the very extensive war flying of the German Zeppelins, and the 2,500,000 miles flown by the British airships during the war, it will be seen that, excluding enemy action, the loss of life is extraordinarily small. The danger in soundly-built well-equipped airships flown by competent personnel is so small that in my opinion it will come to be regarded as nothing more than an every-day risk.

In the case of sea-going ships during the last hundred years, the safety has been very greatly increased, due mainly to the increase in size and the use of more powerful propelling machinery, enabling the modern ship to meet the worst storms without much fear of foundering or of being driven on to a lee shore. The same improvements are to be expected in airships, and the larger airships of the future, fitted with more powerful and reliable machinery, will necessarily be still safer than the airship of to-day.

Modern airships have proved themselves capable of flying through practically any type of weather. There is no doubt, however, as already stated, that at present the most violent types of electrical storms are an undoubted danger to all forms of aircraft.

Fortunately, however, although the wind speed in the centre of these disturbances has

been known to reach as much as 300 miles an hour, the actual speed of such a storm over the ground seldom exceeds 50 miles per hour, and with ordinary navigation there is no reason why airships should blunder into the centres of such storms. At the worst, the danger from violent electrical storms appears to be less than the danger of rocky coasts and shallows to the sea-going ship.

Another important factor in the safety of airships is that all minor engine repairs can be carried out whilst flying. Also, owing to the number of separate machinery units, serious engine failure is reduced to a minimum.

Fog does not constitute a real danger to airships. With present methods of navigation it is not necessary to see the ground in order to navigate accurately between bases. The bases, however, should be situated in localities comparatively free from fog, to prevent delay in landing.

Regularity.—If transport by air is to possess anything more than a very limited future, it must be possible to know beforehand when the machine is going to leave and approximately when it is going to reach its destination. Regularity in this direction is essential. The chief cause of irregularity for airships up to the present has been wind, the main difficulty being the handling of ships on the ground, and the impossibility of taking them in and out of their sheds in a cross wind of much over 20 miles per hour. This difficulty has now been solved by the development of the mooring mast. With the mooring mast it will be possible for airships to embark and disembark passengers and freight with sufficient ease to meet practical requirements. It will be realised, however, that the selection of the site for all landing bases should always be largely influenced by the local weather conditions, which are not always favourable at the great centres of population.

Irregularity in length of passage due to adverse winds encountered during flight is now the more serious problem. Bad weather is usually confined to small areas, and, for this reason, much greater difficulty will be experienced in maintaining regularity over short routes. For the long routes, however, the various weather disturbances will tend to even themselves out, and no insuperable difficulties are anticipated in achieving regularity over correctly chosen routes. An example of regularity obtained even over a short route is afforded by the German airship "Bodensee," which recently carried out sixty flights between Friedrichshafen and Berlin in 64 days, although she was a new and comparatively untried type of airship.

Carrying Capacity.—I think the carrying capacity of rigid airships can be best illustrated by the accompanying Table:—

	Bodensee (German).	*R 34* (in commission).	*R 38* (under construction).	*R X.*
Length (in feet)	590	639' 5"	695	740
Capacity (in c.f.)	700,000	2,000,000	2,700,000	4,000,000
Tonnage	21·3	60·7	82·0	121·5
Maximum Speed (in m.p.h.)	80	58	70	80
Economic Cruising Speed (in m.p.h.)	60	50	60	60
**Freight Carried* (in tons)—				
For 1,000 miles	·28	9·38 (65)	23·26 (160)	34·64 (240)
" 2,000 "	—	5·26 (37)	15·00 (105)	22·28 (155)
" 3,000 "	—	1·14 (8)	6·78 (47)	10·0 (70)

* The figures in brackets show the equivalent number of passengers which should be carried, assuming 7 passengers to the ton.

A good idea of the passenger carrying capacity of airships may be obtained from this Table. The numbers of passengers given are of course only approximate, and will be limited by the amount of accommodation which could be provided. A maximum of about 100 to 120 passengers is considered quite feasible, the balance of the freight being carried in mails, parcels, and high-grade merchandise.

The following Table shows the increase in performance between a 2,000,000 and 10,000,000 cubic feet capacity rigid, allowing only for the increase in performance due to increase in size.

A still further marked increase in performance can, however, be confidently predicted due to improvements in design and to slightly more economical structure which will be practical in the larger ships.

PERFORMANCE TABLE.

		Rigid of 2 million c.f. capacity.	Rigid of 10 million c.f. capacity.
Length		645 feet	1,100 feet
Diameter		79·5 feet	135·5 feet
Gross lift (at 68 lb./1,000 cubic feet)		60·7 tons	303·6 tons
Disposable lift (60 per cent. gross lift)		36·4 tons	182·2 tons
Crew, ballast, food, etc. (15 per cent. gross lift)		9·1 tons	45·5 tons
Dischargeable lift (45 per cent. gross lift)		27·3 tons	136·6 tons
Maximum speed		78 m.p.h.	78 m.p.h.
70 M.P.H. (normal full speed)	Maximum range*	67·9 hours 4,750 statute miles	115·5 hours 8,000 statute miles
	H.P. developed†	1,700	5,000
45 M.P.H. (comparison speed)	Maximum range*	218 hours 9,820 statute miles	364 hours 16,400 statute miles
	H.P. developed†	530	1,580

* Fuel and oil consumption has been taken on the basis of ·53 lb. per B.H.P. hour.
† Thrust H.P. has been taken as equal to 70 per cent. of B.H.P. at full speed, and 60 per cent. at 45 m.p.h.

higher than that outside, so that if there are any leaks in the side of the car, warm air will be passing out, rather than cold air passing in. This will prevent draughts, and ensure an even and suitable temperature.

Comfort.—Comfort in aerial transport is essential if it is to have any extended future. The advantage of this speed is completely thrown away if the passenger on landing is physically or nervously exhausted, and has to recuperate before carrying out the object of his journey. In the large airships this need never be. Ample accommodation can be provided, both sitting accommodation during the day and sleeping accommodation at night.

The slides show the interior arrangement of a proposed passenger car. Special attention has been given to the importance of giving each passenger a good view, and the windows are so arranged that they can see both outwards and vertically downwards should they wish to do so.

Passengers sit facing each other with a table between them, rather like a large Pulman car. They can arrange the chairs and tables for "bridge" as they feel inclined. Sleepers will be provided in the shape of bunks which fold down and allow the passengers to sleep athwartships. My experience up to date is that one sleeps uncommonly soundly in an airship. On the first night of our journey in R 34 to America, I went to bed at 9 p.m., and slept soundly till 9 a.m. next morning.

The whole of the passenger car will be heated by steam generated from the engines.

Air will be admitted at the forward end of the car, where it will be warmed over radiators. The pressure inside the car will be maintained slightly

The car will be arranged so that it will not be necessary to restrict smoking any more than in a railway carriage, as the car will be completely isolated from any possible risk of fire from gas or petrol.

A kitchen with at least as good accommodation as any railway restaurant car will be provided, and our experience to date is that one's appetite in the air is extremely good.

One is struck by the absence of vibration and noise in a large airship, and the absence of smoke or dirt generally is a distinct asset.

Compared with transport by sea, the almost complete absence of sea-sickness is an important consideration. Being a shockingly bad sailor myself, I can sympathise with others, and I can assure you the motion such as there is in a large airship is so slow that there is no excuse whatever for sea-sickness.

Pleasures of Travelling at Low Altitudes.—I could speak to you for hours on this subject, but must necessarily cut this very short and get on with the more serious subjects in the paper. I shall never forget, however, the feelings not only of myself, but of every member of the crew of R 34 as we passed over Nova Scotia on our outward journey to New York last June. We were all feeling rather jaded, having been 59 hours on end over those weary wastes of water in the Atlantic, and the joy we felt at again passing over terra firma is difficult to describe.

And such a country we found spread out

beneath us. Huge expanses of dense forest on every side with hardly ever a sign of habitation—lakes, rivers, and here and there a tiny clearing where an enterprising settler had succeeded in penetrating. We were only 800 feet above the trees and going very slowly against a head wind, and there appeared to be no detail that we could not see. We could see the trees each settler had cut down during the previous winter neatly stacked and looking exactly like little bundles of asparagus. We could see where he got his water, the extent of his housing accommodation, and the amount of land he had cultivated. We could tell the nature of the soil. We got quite an insight into the rainfall of the country; the types of trees which did best; the bird life; depth of the lakes and so on; the natural drainage of the country stood revealed, and last, but not least, the glorious smell of those pine woods acted as a refreshing tonic and put new life into us.

I am afraid that I am not good at describing the pleasures of airship travel at low altitudes, but I hope that everyone of you will soon experience these for yourself.

Speed.—The time taken over the whole journey is the important factor, and the actual air speed is not the sole consideration, although obviously of great importance in reducing the time taken.

In considering long journeys of 1,500 to 2,000 miles, the intermediate landings for refuelling or for trans-shipment, if relays are provided, must necessarily greatly increase the time for the whole journey. Further, the question of flying throughout the night is a most important factor in the time required for the journey. Airships have a great advantage in the fact that they maintain a continuous air speed throughout the twenty-four hours, and owing to their great range have no intermediate landings. A continuous air speed of 60 miles per hour is reasonable to assume. It should also be remembered that the airship, by deviating from its course, can take advantage of favourable winds or slants, or, at the worst, the effects of unfavourable winds can thereby be very considerably reduced. It is, therefore, safe to assume that on the average this air speed will be made good over the ground. Where trade winds, monsoons, and westerly drifts can be made use of, which will be the case on many of the routes, the speed made good can and will be considerably increased.

Assuming, therefore, an air speed of 60 miles per hour, and allowing for the probable effect of wind on the various routes, our principal Dominions can be linked up independently of bases in foreign countries as follows:—

Journey.	Intermediate Landings (half-day halt allowed).	Duration of Flight.	Present Mail Transit.
England to Egypt	0	2 days	4-6 days
England to India (*viâ* Egypt)	1	4½ ,,	14 ,,
England to South Africa (*viâ* Egypt)	2	6 ,,	17-19 ,,
England to Australia (*viâ* South Africa)	3	10 ,,	25 ,,

Night flying is of the greatest importance, and it is here that airships are of special value. In fact, it may be stated that airships can be more easily and efficiently flown at night than in the daytime. If a passenger can leave after dinner, sleep comfortably on board, and reach his destination in time for breakfast next morning, where, owing to existing means of transport, it would have been necessary to spend, say, twenty-four hours in the train or boat, a great saving is achieved. Thus, one complete business day would be saved, provided always that the accommodation is sufficiently comfortable not to impair the efficiency of the passenger. The journey between London and Copenhagen is an admirable illustration of this.

Cost.—If I were to be asked suddenly to-day "Is the big airship a commercial proposition or is it not?" I should hedge a bit and say, "Now, this is rather a difficult question you've asked me!" But, having recovered from my astonishment, I should reply: "I am convinced that the big airship will be a commercial proposition, but I am not in a position to say that it actually is to-day, for the very good reason that it has not yet been proved one way or the other." Airships have not yet had an opportunity of showing what they can or cannot do commercially. Up till now they have only been used for military purposes in this country. I say advisedly "in this country," because in Germany they have been tried out very considerably for commercial purposes, and the answer they would give in that country

to the question I have so carefully shirked would, without doubt, be in the affirmative.

I will now endeavour to give you some idea of the cost of the rigid airship transport. I think you will agree with me that at the present stage of development of the airship this is a most difficult subject, as although many notable flights have been carried out by our own and German rigid airships under war conditions, yet these flights have only proved that there are great possibilities in the airship for commercial purposes, and have not produced sufficient data to enable actual running costs under commercial conditions to be stated. Considerable experience, however, has been gained during the past three years which is sufficient to warrant certain conclusions, and on the assumption that these conclusions are correct it will be possible to form some idea of the cost of this form of transport.

I propose to consider an airship of 2,750,000 cubic feet, similar in size to airship R 38, now building at Bedford in the Government airship dockyard. As I have previously pointed out, an airship of this size would be capable of carrying fifteen tons for a journey of about fifty hours' duration at a continuous air speed of 60 miles per hour. I propose to assume that this airship would fly about 2,500 hours in the year, and on an average would make good a ground speed of only 45 miles per hour (although I am personally confident that a ground speed of nearer 60 would be made good). This would make the yearly ground mileage covered about 112,500 miles. This amount of flying allows the airship to be laid up for three months in the year. From past experience it is considered that this will be considerably exceeded by airships operating on long distance routes.

The Cost of Airship Transport may be divided into: (1) the cost of the airship; (2) the cost of the base; (3) cost of operating the airship; (4) cost of running the base.

1. *The Cost of the Airship.*—The war cost of an airship of 2,750,000 cubic feet (R 38) is approximately £400,000, but this cost must not, I feel, be taken as a guide to the future cost of construction. To justify this statement I must point out in the first place that the airship industry is a comparatively new industry. Progress in design was rapid and construction was slow, so that airships were obsolete long before they were completed. Standardisation of production was, therefore, impossible. Progress in design also led to alterations and improvements during construction which, of course, meant delay and consequent increased cost. For these reasons, amongst others, airships in this country took anything between fifteen to twenty months to build, whereas in Germany, where development permitted a degree of standardisation, airships of about 2,000,000 cubic feet (R 34 size) took only three to four months to build. I therefore feel, and I am not alone in the matter, that as soon as something approaching a regular airship construction trade is established, the cost of a commercial airship similar in size to R 38 will be under £200,000. I must also add that future airships will be of more rugged and simple construction than those built in the past, with the object of attaining low first cost cheapness of maintenance, and a longer life. I therefore propose to take the cost of such an airship at £200,000.

2. *The Cost of the Base.*—A commercial airship base will consist of housing sheds, gas plant, workshops (situated in the annexes to the sheds) for fabric workers, carpenters, engineers, and allied trades. Landing rights over surrounding ground will be required, the extent of which will depend on local conditions. (I should mention here that any ground reasonably flat, the quality of the surface not being important, is suitable for landing.)

The cost of establishing such a base with a shed to house two 2,750,000 cubic feet airships, with all necessary equipment and plant, including a fair margin for such services as drainage, water supply, roads, but excluding cost of land, accommodation for station personnel or hotel for passengers, would be about £550,000 on present-day prices. I may point out in passing that housing sheds can easily be lengthened to meet development, provided they can be built sufficiently high and wide in the first instance.

A similar base, but with shed to house one ship, would cost £400,000.

An additional £25,000 would be required to erect and equip one mooring mast at a base.

A mooring station would consist of a mooring mast complete, gas plant, and small office and store accommodation. The size of the gas plant would depend on the amount the base is used, but a base with gas plant to produce sufficient gas for, say, two airships calling once a week, would cost about £45,000 on present prices.

The cost of the bases may appear high. It must be remembered, however, that only about five bases will be required to allow services to be run to all parts of the Empire. Bases will gradually be increased in size, and extra sheds will become necessary for repair purposes as traffic increases.

An argument invariably produced against airships is the prohibitive cost of their bases. It is interesting, therefore, to take a wide glimpse into the future. Let us make, for example, a liberal estimate of the possible future airship requirements of the Empire, and assume that this is completely met by a fleet of, say, 120 airships. This enormous fleet, with the aid of mooring masts, could be efficiently operated from five bases mentioned above, allowing for six sheds at each base. The capital outlay involved for these bases and attendant mooring stations would be something in the neighbourhood of £10,000,000.

To get the right prospective one must compare this capital outlay to the hundreds of millions laid out in permanent ways for railways, and to the enormous sums expended in docks and harbours for shipping.

3. *Cost of Operating the Airship.* — This may be divided into: (1) maintenance; (2) depreciation; (3) crew; (4) gas; (5) fuel.

Before any idea of cost of maintenance and depreciation can be obtained, it is necessary to state the probable life of an airship and its part. For this purpose the airship may be divided into: (1) fabric; (2) engines; (3) hull. With regard to fabric this may be sub-divided into: (*a*) outer cover; (*b*) gas-bags. Present experience enables the life of the outer cover to be placed at one year (2,500 hours flying), and that of the gasbags at two and a half years.

With regard to engines, owing to the fact that airship engines are not run at their full power, except in emergencies, the life can be placed at 2,500 hours, or one year.

With regard to the hull, the opinion of those best qualified to judge, places the life at not less than five years. Tests of the duralumin of No. 9 rigid after three years' use showed no weakening power. The life of the hull I therefore propose to take as five years.

1. *Maintenance.*—Under this heading are included the necessary repairs and overhauls to the fabric, engines, and hull, and replacement of fabric and engines during the life of the airship. The sum required under this heading is estimated at £40,000 per annum, or 20 per cent. of the first cost (£200,000), and this sum will be included in the operating costs.

2. *Depreciation.*—Assuming a five years' life for the whole airship, a sum of £40,000 per annum will be required, which will enable the airship to be replaced at the end of its estimated life (five years), and this sum will be included in operating costs.

3. *Crew.*—Allowing salaries slightly in excess of those now paid for equivalent work on service airships, the yearly cost of the crew would be £9,000.

4. *Gas.*—From experience during the war with present day methods of producing gas, assuming that the plant would be kept reasonably fully employed, the cost should not exceed 15*s*. per 1,000 cubic feet, which would be a net cost including maintenance and depreciation charges on the plant. The consumption of gas, assuming 2,500 hours (112,500 miles) flying per year, may be taken as 16,000,000 cubic feet, which would cost £12,000, or 2*s*. 2*d*. per mile made good over the ground.

5. *Fuel.* — Based on present day contract prices for petrol and oil, the cost under this heading throughout a year may be taken as 5*s*. 6*d*. per mile made good over the ground. I may mention here that R 34 in her Transatlantic flights averaged 1⅓ gallons of petrol per mile made good.

The above charges may be summarised as follows:—

(1) Airship maintenance . .	£40,000
(2) Airship depreciation . .	40,000
(3) Flying crew	9,000
(4) Gas	12,000
(5) Petrol and oil	30,937
	£131,937

or, on the yearly flying basis assumed, this would amount to 23*s*. 5*d*. per mile.

6. *Cost of Running the Base.*—A description of a base has already been given, but the cost of running such a base must now be considered. One hundred and twenty skilled men would be sufficient to run the gas plant and do all repairs to visiting airships; a further 50 unskilled workmen would be required for rough work. Allowing £5 per skilled and £3 per unskilled man per week, this would amount to a yearly charge of £39,000. I propose to allow a round sum of £12,000 for overhead charges (for such items as salaries, office expenses, etc.). Thus, the yearly cost of this base would be £51,000. Of the 170 men whose wages are included in this figure, I estimate 90 would be available for

landing parties. However, until landing to a mooring mast is in general use, this number would not be sufficient, and I must therefore allow for a further 200 unskilled labour for this purpose. Although this labour might in certain places be engaged as required, I propose to base my costs on the assumption that they must be permanently employed. Assuming they are also paid £3 per week, this would mean a further yearly expenditure of £31,200, bringing the total yearly expenditure to, say, £82,200.

I do not wish to enter into a discussion on the very important question of the ownership of bases, and I therefore propose, for the purpose of this paper, to assume for example that the Governments concerned would erect these bases and lease to a company for a yearly rental of six per cent. of the cost of erection. I would like to add here that the rental suggested should be more than sufficient to cover depreciation, maintenance, and repair charges. In my opinion, these bases would be national assets, and a large cash return on the cost of erection could no more be expected from such an outlay than from money spent in harbour works, such as breakwaters, channel dredging, etc.

The total yearly cost of the base, including the rental suggested above, will therefore amount to £116,700.

A mooring station, such as has been described, would require about twenty skilled men, which would include gas workers, engineers, drivers, clerks, etc. A further ten (unskilled labour) would also be required. Allowing a wage of £5 and £3 respectively, this would entail a yearly cost of £6,760, to which must be added depreciation, maintenance, and overhead charges. I propose to allow a total of £12,000 for the running of this station.

The yearly charges of bases and mooring stations on these assumptions may be tabulated as follows:—

	Double shed base. £	Mooring station. £
Rental (6 per cent. on £575,000)	34,500	5,240
Overhead charges	12,000	—
Personnel (permanent) . . .	39,000	6,760
Landing personnel	31,200	—
	116,700	12,000

Cost per ton-mile.—I have now outlined the probable "all in" costs for a complete airship service. To reduce the cost of running the base to cost per mile, operations on an actual route must be considered. I do not want to take some case which is only capable of fulfilment in the distant future. As I have already stated, airships in the future will undoubtedly only use their sheds for repairs, and in this way the percentage which each ship must bear of the terminal costs will be considerably reduced. I propose to assume that each ship operating will have its own shed accommodation, and I will therefore consider the case in which there are two bases, each with one double shed, also one mooring station, and that airships actually under construction (R 38 type) are employed.

I must mention that in order not to complicate my conclusions, I have assumed that one company is running both airships and bases.

I have allowed a sum for working capital, but I have not shown any charge for, may I call it, head office expenses, advertising, etc., but on the other hand, neither have I allowed for any revenue from special charters, advertisements, and many other ways in which a commercial airship company would earn additional revenue.

The route I propose to take is England—Cairo—India. I am assuming the two stages of the journey will each take fifty hours. I also allow a half-day stop at Cairo. England and Cairo would each have a double shed, and India would have a mooring-out base, which I have shown at Karachi. The four airships would each fly 2,500 hours per year, which it will be remembered, allows for a three-months' lay up for each ship every year. This would permit of a weekly service being run each way from England to India.

The cost of the service on the assumptions taken is as follows:—

Capital Expenditure—

	£
Cost of four airships, at £200,000 each	800,000
Cost of mooring station at Karachi	45,000
Working capital	200,000
	1,045,000
Interest on Capital Expenditure and Reserve Fund (15 per cent.)	156,750
or, say	157,000

which is equivalent to 7*s.* per mile flown over the ground.

I have neglected the whole question of insurance, as it is impossible at present to include a reliable estimate of the probable rate.

Cost of operating the airships, as previously stated, 23*s.* 5*d.* per mile flown over the ground.

Cost of running the bases per annum—

	£
English base	116,700
Cairo base	116,700
Mooring station, Karachi .	12,000
	245,400

which is equivalent to 11*s.* per mile made good over the ground.

Tabulating these costs I arrive at the following:—

Interest on capital expenditure . .	7*s.* per mile made good.
Cost of operating the airships . .	23*s.* 5*d.* ,, ,, ,,
Cost of running the bases	11*s.* ,, ,, ,,

or, an "all in" cost of 41*s.* 5*d.* per mile made good over the ground.

As I have already stated, each of these four airships would carry, as a conservative figure, 15 tons of commercial load, for a journey occupying 50 hours, which would make the "all-in" cost per ton-mile, 2*s.* 9½*d.* for such a journey.

Allowing seven passengers to the ton, which for practical purposes amounts to each passenger being allowed 1 cwt. of luggage free, and 1 ton of mails at 6*d.* per oz. for each stage of 50 hours, the following table is of interest:—

airship flying has been highly tested in Germany with successful results, and over the routes shown on the chart, with the assistance of the mooring mast, I have every reason to believe that regular services will be maintained.

Finally, as regards cost, my estimates have been based on a British airship actually under construction, and also on what I consider to be conservative assumptions.

Progress in airship performance has been most marked during the last few years, and each successive class shows great improvement over its predecessor. I feel, therefore, I am fully justified in assuming a further increase in performance in the 4,000,000 cubic feet airship, such as could be designed having regard to the many improvements which would be incorporated both from the point of view of better performance and cheaper construction. The reason I did not base my estimates on this class of ship was that she is not being built, although she could be constructed and housed in existing sheds. If, however, a cost per ton-mile is worked out for such a ship, making reasonable

England to	Airship.			Steamer.
	Approximate Time of Transit.	Mails (1 ton carried).	Passengers.	Approximate 1st Class steamer passenger fare.
Egypt	2 days	6*d.* oz.	£50	£45 to £50
India	4½ ,,	1/- ,,	100	£65 to £70
South Africa	6 ,,	1/3 ,,	120	£70
Australia	9½ ,,	2/- ,,	190	£115 to £128

The above figures are based on airships actually under construction (R 38 class), showing a profit of 15 per cent., and are based on the carriage of 75 per cent. of the possible passengers.

Conclusion.

In conclusion, it may now be fairly stated that the airship itself can be regarded as having successfully emerged from the experimental stage, but we have yet to prove the airship to be of commercial value. To prove it we must try it. I think you will agree with me there are good prospects of success.

The criticisms invariably levelled against the airship are slow speed, irregularity, and high cost. I hope I have clearly answered these three criticisms.

With regard to speed, it has been shown that over long distance routes such as I have mentioned, the airship, far from being slow, sufficiently reduces the present time of transit to alter entirely our accepted views of distance.

Then, as regards regularity, commercial allowance for operational improvements, every material reduction from the 2*s.* 9*d.* per ton-mile previously quoted, will result. I estimate the "all in" costs of such an airship at 1*s.* 9*d.* per ton-mile.

It is common knowledge that one of our chief national assets of to-day is our mercantile fleet, and I feel sure that a British commercial airship fleet of the future will be of similar value. It will assist in maintaining the security of the Empire, and will also provide the means of bringing our scattered Dominions in closer touch with the Mother Country.

[During the reading of the paper, Lord Londonderry was called away to the House of Lords, and the Chair was taken for the remainder of the meeting by Major-General Sir Frederick Sykes, K.C.B., G.B.E., C.M.G., Controller-General of Civil Aviation.]

DISCUSSION.

The Chairman (Sir Frederick Sykes), in opening the discussion, congratulated the author on his most interesting paper and on the wonderful

photographs he had shown. With regard to the question of mooring masts *versus* sheds, the author said that some people were rather pessimistic in regard to expenditure on sheds, and perhaps he was one of those to whom the author referred. It was true that he thought the big sheds which were at present necessary were a handicap upon airship development under the present financial conditions, but the author said that the mooring mast was gradually easing the pressure with regard to sheds, and there, he thought, lay a tremendous possibility of help for the future of airships. It was before the war that a mooring mast was first tried at Farnborough, when No 1 Squadron, Military Wing, Flying Corps, was there. The author then had to conduct experiments with the little airships made at that time, and as far as he remembered, although useful results were gained from those experiments, the noses came away from one or two of the ships on the masts. Much progress has been made since that time, and he was quite certain that the mooring mast would be of great value, but he thought further mechanical developments should be aimed at in regard to airship sheds. If the airship of the future was to be put upon a commercial basis, mechanical means must be devised to save the somewhat large ground *personnel* that was at present necessary to manœuvre ships into the sheds when the wind was at an awkward angle for doing so. The Germans had made developments in that respect to a certain extent, but even they, after a great deal of work, still found vast difficulties in regard to the matter. He thought, however, that it was a proposition which the inventive genius in this country could overcome if it was called upon to do so. He fully agreed with the points that the author raised in regard to the necessity for commercial airships. In the same way that the Mercantile Marine provided a reserve for the Navy, civil aviation would assure a reserve to Service aviation. Airships had made a great advance, but he thought there was still a great deal of experimental work to be done, and he felt it was on a commercial basis that airships could be used both to assist the experimental side of the Service, and also to develop the airship on its proper transport lines.

Major-General Sir William S. Brancker, K.C.B., A.F.C., said he was rather sorry that the author had not mentioned the heavier-than-air side of aviation, because his neglect to refer to it might encourage the idea that heavier-than-air aviation and lighter-than-air aviation were serious rivals. Personally he was convinced that was not so, but that they were essentially supplementary the one to the other. As the author had shown, the airship was eminently suitable for long-distance journeys over wide expanses of sea or deserts or undeveloped country, whilst the aeroplane, which was capable of considerably higher speed, was essentially a short-distance vehicle which he thought would be the collector and distributor for the big airship services when they were started. The airship and aeroplane had very much in common, in that at the present moment those interested in the development of either could prove that it must be a paying concern in the future. At the same time it must be realised that there were two serious enemies to be faced by both; first the weather, and, secondly, the question of finance, which was an extraordinarily difficult matter at present.

Sir Alan Garrett Anderson, K.B.E., said the paper was an extraordinarily interesting one, written by an admitted enthusiast, and the evidence the author had given must be discounted in the light of that knowledge. He believed, however, that all the author had said about the possibility of navigating airships was true. He did not think there was any inherent impossibility in their navigation, or that there would ultimately be found to be any impossibility in making them pay. He agreed with General Brancker that they did not compete in the least with the heavier-than-air machines. The voyager in an airship obtained a feeling of complete security —one did not notice any motion at all; moreover, there was one peculiarity that the author did not mention, namely, that there ceased to be any wind, because the airship was one with the wind. When travelling at fifty knots there was always a steady fifty-knot breeze; one did not pass from a calm to a storm and so on. He thought the chief drawback to travel by air would be the monotony that would be experienced when going long distances at a high altitude. Airships had now passed through one experimental stage, but further experiments were necessary before the public could be asked to subscribe money on a commercial basis. They would want to know more, for instance, about the figures the author gave with regard to depreciation; he himself said in the paper that progress had been so rapid that a ship became obsolete before it was built, and that, of course, upset any calculation of costs. Millions of pounds had been spent to bring airships up to their present state of development, and there was an immense amount of material available, and he therefore thought that in the national interest the Government should carry out further investigations, either themselves or through other people. In a very few months it would be possible to learn whether electrical storms could be avoided, how long the engines would run, and all the other things that a commercial man wanted to know in order to see if he could make the airship pay. As soon as it was understood how to make it pay, someone would go to the Government and say: "For so much a year I will relieve you of the whole cost of maintaining your airship fleet, and you shall have these commercial ships in time of war," and very soon after that they would simply pay in the ordinary way. He did not think the cost of the bases or the expense of each ship need frighten anyone. The cost of £500,000 for a base, or, say,

£2,000,000 for equipping a long route with bases, was not so much as the cost of one big liner. Ocean ships required lightships, lighthouses, dredging channels, etc. Until it was known, however, that airships would be able to run regularly, which was the essential thing, people could not be asked to subscribe. The Government should go ahead at once. The most expensive thing they could do at the present time was to dawdle, and in regard to airships, as in many other enterprises, courage and economy went hand in hand.

Major G. Hurlstone Hardy said that, contrasting the prospects of commercial aviation with the transport of the present day, shipping and railway carriage, he was not convinced by the optimistic ideas that had been put forward. There were two difficulties with regard to airships to which he wished to refer. One was the impossibility of locating where an airship happened to be when under adverse and comparatively unknown control by the wind. When sight was lost the navigating power of the compass was reduced to a minimum. One only knew the direction in which the helm had kept the ship going, and a side wind might take it miles away. That had been proved in the case of the three aeroplanes that set out from North Wales for Dublin and were never heard of again. It was conjectured that they got into a cloud fog so that they could not see the sea or the land, and that they drifted south of Cork and out into the Atlantic. Another case in point was that of the last German airship attack on London, when of the large number that arrived in England some three were brought down, others landed in most distant places, and some were never heard of again. He did not feel at all satisfied that navigation could be carried out in a cloud fog. The other point, to which he wished to refer, was the author's estimated cost of 2*s.* 9*d.* per ton-mile. The reconstruction of the country demanded more extensive commerce than had ever been known before; transport for the necessities of life was required in much larger bulk than ever before, and it ought to be in pence and not in shillings per ton mile. When one considered the outlay necessary on landing stages and all the other things connected with airships it would be seen that the expenditure when contrasted with other forms of transport was very great — it was just the difference between a commerce of luxury and a commerce of democratic necessity. Ships had, with feasible repair, a useful lifetime of sixty years or more; railway engines and rolling stock served for, say, thirty years, and road vehicles for a little more or less. But the lifetime endurance of aeroplanes and airships should be reckoned respectively in weeks and months rather than in years, inasmuch as repairs engendering safety in such frail craft were not feasible in any way comparable to those ordinarily carried out in structures built on more solid designs. Counting cost against cost in connection with volume of traffic, the figures would work out enormously in favour of naval commerce and intercourse. He agreed as to the prospects of aviation for exploration and for other special purposes, but there were such severe limitations on its commercial prospects as would discountenance remunerative expectation.

Commander E. S. Land, C.C. (U.S.N.), wished to congratulate the author on his fascinating paper, which rather brought to one's mind Jules Verne's "Twenty Thousand Leagues under the Sea" and Kipling's "Night Mail." The things described in those books had now been materialised in the submarine and the airship. In America there was a certain class of man sometimes called a "promoter," the kind of man who would furnish the ocean if someone else provided the ships. The author was prepared to furnish the airships and it appeared that the British and American Governments were prepared to furnish the air. Pioneers in any line must expect to run up against rocks, and that was what the pioneers of aviation were doing at the present time. One point in which he was particularly interested was interchangeability of commercial and military airships. He thought it was easier to convert a military airship into a commercial airship, and *vice versâ*, than it was to convert an old-time sailing ship into a man-of-war. Two matters had to be considered in that connection: first, material; and, secondly, *personnel.* With reference to the question of mooring masts *versus* sheds, he understood the Germans still adhered to the rotary shed proposition. He did not think commercial aviation could make proper progress without Government help. The Government had helped in every transportation scheme that had ever existed. The best rail-road system in the United States was not built by private capital alone, but was assisted by Government capital. The general attitude towards the subject seemed to be one of indecision, and if a decision was not speedily arrived at our late enemies would leave us "asleep at the switch."

Colonel E. Gold said he did not think from the point of view of the mechanics of the atmosphere there was a great deal of danger to the airship of the future, but it was quite certain that there would be many occasions in an airship service between India and England when an airship arriving in this country would not be able to reach a definite fixed place, such as Pulham. That difficulty could be overcome by having mooring masts not only at Pulham, but also along the route across the Continent; then aeroplanes could come and take the passengers for the rest of the distance and not keep them waiting for the wind to fall at Pulham. With regard to the equatorial region, he was not quite clear that the electrical difficulty, that was to say, the difficulty of discharge inside the airship or through the covering of the gas holders, had been met. Probably, by careful observations, even without an elaborate system of warning, an airship

would be able to avoid the centre of tropical revolving storms, but it could not avoid getting into regions where there were very great variations in the electric potential, and that might produce discharges from the ship. There was one meteorological point on which the author did not lay stress, and that was the advantage an airship would have in being able to avoid very high temperatures when travelling through equatorial regions. An airship travelling from this country to India could do so in temperatures not exceeding 80° F., and the passengers would never be subjected to those discomforts which arose from being shut up in a cabin with a temperature of 110° F. A great deal could be done in airship transport by utilising what was already known about the general wind, and also by utilising the winds in different layers in the equatorial regions. Roughly speaking, if the wind was west it would be a west wind all the way up, but if it was an easterly wind it would normally change into a westerly wind up above. In the extensive regions near the Equator, where there were easterly winds down below, there would usually be westerly winds up above, or at any rate the easterly winds would decrease. The airship would be able to take advantage of that, and so utilise the energy of the sun translated into motion in the atmosphere. The existence of mankind depended on the energy it obtained from the sun, and at the present time the energy obtained direct from the sun should be used in every practicable way, and the stored-up energy of the sun, such as in coal, should be kept as long as possible for use where the direct energy could not be employed. Airships provided an opportunity of doing that by making use of the wind, thus making an economical use of the energy that was being received in such vast quantities day by day from the sun.

Wing Commander T. R. Cave-Browne-Cave, C.B.E., said the paper had been particularly interesting to him, because, although he was fairly well acquainted with what had been done in regard to Service airships up to the present time, he had had nothing to do with deducing from those data what could be done with airships in a commercial way. The author stated very clearly the data on which his calculations were based, the deductions from those data were then arrived at by a method which was stated, and thus definite conclusions were obtained. If one agreed with the data and could not find any flaw in the method of deduction, one must accept the conclusions. That was his position with regard to the paper, although the results obtained, such as those shown in the tables, were probably distinctly surprising to the majority of those present. With regard to the question of whether the airship was still in an experimental state, he thought that, although there was still an enormous amount of experimental work to be done, it must be realised that sufficient was now known about airships and the difficulties they experienced to be able to tell along what lines research was required. The amount of *wasted* experimental effort should in future be very small indeed. One rather remarkable figure given in the paper was the cost of the airship. The cost of an airship such as the R 38 was about £400,000, but the author suggested that the cost of a similar airship in the future would be about £200,000. That seemed a very considerable reduction, but he thought it was a reasonable one. In the construction of airships by the present methods a very large proportion of the cost was allocated to labour. The present methods of construction were so extremely primitive compared with what they would be in the future that experience in construction was bound to lead to enormous economies. For instance, the gas-bag of a ship was now covered by hand with gold-beater skins, each covering a space of only about 5 in. by 10 in. or 12 in., and that would be done by machinery in the future, which would mean a considerable reduction in cost. With regard to the difficulty that had been mentioned of finding out one's position when in an airship, that was done quite irrespective of one's dead reckoning. One method was by directional wireless and the other by taking sights as employed in the Navy. The case that had been quoted of the three aeroplanes that set out to go to Dublin was not entirely to the point, because, if those machines had any means of determining their position at all, which he thought was very doubtful, they had very difficult conditions in which to use them. Those conditions did not apply in an airship. One could determine one's position far more easily in an airship than in a destroyer or in many merchant craft. The airship had the advantage that it was able to go to what altitude it liked in order to get a clear horizon, whereas a destroyer or other surface ship which got into a fog might have to slow down for that reason. With regard to the question of danger from lightning, he might quote from the trials of R 24 when moored to a mast. In that case the airship was connected to earth through the mooring mast, down which there was a water main. Whilst there a thunder-storm of quite exceptional violence passed right over the station. The lightning in the neighbourhood of the ship was so intense that although there was no other illumination in the ship it was possible to read instruments clearly at night. Considering that the thunder-storm was quite exceptional in its violence, and that the airship was connected to earth and yet was not affected by the lightning, he thought the system adopted at present of bonding together all the various metallic parts of the ship must be regarded as satisfactory. The figure of cost given in the paper had been worked out generally in the same manner as had been done for heavier-than-air propositions, and he thought it would be extremely interesting to compare in detail the basis on which the author's costs had been worked out with the basis on which figures had been

worked out for the corresponding heavier-than-air suggestions.

Mr. H. White Smith said a great deal had already been done in regard to airships under military conditions, and it was now necessary to know more about them from a commercial point of view. It was to be hoped that, either with Government assistance or by private enterprise, something might be done to institute what might be called an experimental line of commercial airships, possibly from this country to Egypt, which was a route that seemed very suitable for such a project. There were airship sheds in this country and also, he believed, in Egypt. Such an experimental route would furnish data on which to judge whether commercial airships could be run successfully. On such a route the airship had an advantage over the aeroplane because it could go the whole distance straightaway, whereas the aeroplane had to pass through France, Italy, possibly Greece and other countries, and the people operating the aircraft of those countries would want to take their part in the project, thus raising possible international difficulties. Such a route would also have an advantage in that it would link up with the proposed heavier-than-air experimental service which would be instituted from Cairo to Karachi.

Air-Commodore Maitland, in replying to General Brancker, said he did not mention aeroplanes in the paper because he was trying to confine himself entirely to the airship problem, but he quite agreed that the airship and the aeroplane must work together. They were going to be of the very greatest help the one to the other; in fact, he believed they would be quite indispensable to each other. The big airships would do the long oversea routes and a great many of the long-distance overland routes, and the aeroplanes would radiate out in every direction, both from the airship bases and also from their own bases. He quite agreed with Commander Land that the Germans would leave us behind in the matter if we did not "get a move on." The Germans were very enthusiastic about the airship and were certainly making good progress, which would be increased when they got greater opportunities for going ahead. The reason the Germans did not use mooring masts was that their weather was a great deal better than that in this country, and so they could get their airships into the sheds very much more easily than we could. In spite of that, he believed that when the usefulness of mooring masts had been demonstrated in this country the Germans would follow suit and erect them in Germany. He agreed that transport per ton mile should be in pence and not in shillings, but we must start with shillings and perhaps would be able to bring it down to pence later on.

On the motion of the Chairman, a hearty vote of thanks was accorded to the author for his interesting paper, and the meeting terminated.

NUTS AND MEDICINAL PLANTS IN COLOMBIA.

In the course of a lengthy report on the economic resources of the Cartagena district, the United States Trade Commissioner at Medellin gives the following figures of the exports of forest products from Cartagena in 1918, all of which were gathered by the negroes and natives of the interior, the work extending as far as the headwaters of the Atrato River:—

Balsam copaiba	7,365	lb.
Canine oil	11,401	,,
Cedar and mahogany	1,200,639	ft.
Chicle	86,585	lb.
Ipecac	47,181	,,
Ivory nuts (tagua)	4,063,011	,,
Palm-kernel oil	65,076	,,
Rubber (balata)	395,318	,,
Sisal fibre	20,882	,,
Tannic extract	733,751	,,

Another product that deserves mention is the nut of the corozo palm. This palm is the same as the "cohune" of Central America, and is found in great abundance throughout the Bolivar plains and as far west as the Atrato River. There is an unlimited supply of raw material. When pastures are cleared for cattle the corozo palms are left for the gathering of the seeds. The gathering of the nuts presents no particular difficulty. Two harvests are obtained yearly after the palm has reached maturity, which is attained at the age of four or five years. The nuts are very rich in food value, the oil having been used by the aborigines for centuries. The extraction runs about 25 per cent. of pure oil per weight of raw nuts after drying. About 25 lb. of the nuts, which grow in large bunches near the ground, can be expected from each palm annually.

The tagua nut is one of the principal articles of export of Cartagena. The chief supply comes from the region of the Atrato River to Cartagena for export, although the Pacific coast of Colombia exports large quantities also.

The forests of Bolivar and the regions of the Sinu and Atrato Rivers, particularly the latter, are rich in medicinal plants, such as the ipecacuana, or the ipecac of commerce, sarsaparilla, cinchona bark or quinine, cascara sagrada, and many others. About £10,000 worth of these products are shipped each year from Cartagena to the United States. There are also several palms which produce gums and varnish material, such as the famous ceroxylon palm, but, so far, little or nothing has been done in this region toward the collection of these gums in marketable quantities.

COMMERCIAL USES OF MANJAK IN TRINIDAD.

Manjak is said to be more abundant in Trinidad than in any other part of the world—in fact, with the exception of Utah, Cuba, and Barbados, there are understood to be no other important known deposits. In case of a large demand arising for

manjak, Trinidad probably offers the best opportunity for its production and export as an article of commerce.

While Trinidad is rich in its resources of manjak, the mining of it is as yet only in an experimental stage, and such exports as have taken place have apparently been chiefly for the purpose of testing uses to which it may be put.

In Trinidad itself, writes the United States Consul there, manjak is very rapidly coming into increasing use. Its utilisation in connection with the oil industry is especially important, manjak being produced in close proximity to the oil wells of the island. It is boiled locally with oils at high temperatures, and made into compounds and paints for use in the oil fields for practically every purpose for which a preservative is required—for pipelines, boilers, chimneys, sprocket wheels, pinions, and other ironware, machinery, etc. Entire pipelines are painted with it, and apparently, wherever it is used, the metal, which would otherwise quickly deteriorate in the hot and damp climate, has its life almost indefinitely prolonged. When applied in a liquid state the manjak quickly and readily hardens into a tough, unbreakable, and rubberlike coating. It has a low viscosity, is not affected by ordinary heat, is a most excellent insulating material, and is impervious to both water and air.

The most important use of manjak, and the one for which it has won a reputation for immense saving of money, is in connection with rotary drilling for oil. A soft compound is used on the joints of the pipes between the casing threads and drill stem threads, and this prevents either water, sand, or grit getting into the threads, and so preserves them from being stripped or worn off. It not only acts with particular efficacy in keeping such pipes water-tight and air-tight and free from corroding influences at the joints; but also, having qualities as a lubricant, it facilitates the work of joining and separating the pipes. It has been found much superior for such purpose to white lead or any other substance previously used, and results in very great economy.

The Government of Trinidad is now making important use of manjak in painting the under parts of bridges, and in other cases where protection is required from water; and a Trinidad company has secured excellent results from the use of manjak paints and compounds on steel smokestacks, trucks, fenders, and buffers, galvanised iron cans which are submerged in brine, and iron and steel work in connection with power-house and car building. The company also uses it successfully as an insulating varnish on armatures and electrical connections, and in gear cases of mechanically-propelled vehicles. It has proved especially valuable in connection with overhead canvas-coverings for vehicles, as protection from the hot tropical sun and rain.

The manjak deposits of Trinidad are found within a distance of only about three miles from San Fernando, the second largest town of the island, and within about ten miles of the famous asphalt lake at Brighton. Manjak is much like asphalt in its chemical composition; but while the melting-point of asphalt is low (100° F.), a temperature of over 400° F. is required to melt manjak. It is almost a pure bitumen. It looks like coal, is odourless, and is very hard and brittle, having a pencillated structure easy to separate in its long grains. It is found in long seams between layers of clay.

Manjak was mined in a small way in Trinidad previous to the year 1900, until a serious accident occurred from explosion of gas, resulting in large loss of life and so discouraging the proprietors that mining operations were discontinued. In 1913, however, mining operations were resumed by a company, which, by making use of modern safety appliances—especially safety lamps—has averted any further accidents. There are now five shafts, one of which reaches a 37-foot seam at a 400-foot level. The area where the mining operations occur comprises about 1,600 acres, one-half mile from the Gulf of Paria. The operations could be greatly extended should the business conditions warrant it.

It has not been found profitable to export manjak from Trinidad in its crude state, the price received of only about thirty-five dollars per ton hardly covering the cost of mining—an expense which is increased by the necessity of thoroughly timbering every tunnel and opening because of the loose formation of clay. However, by compounding the manjak with mineral oil, the special preparations thus made have been found to command very good local prices, and to make the mining operations quite profitable so far as they go. There is still considerable experimentation with different mixtures and different kinds and weights of oil for specific purposes, and the manjak which has lately been exported to the United States has been sent there for the purpose of testing whether American oils would prove more economical and useful for mixing purposes than Trinidad oils. It is the intention shortly, adds the American Consul, to erect a plant, either in the United States or in Trinidad, for the manufacture of a variety of manjak paints and compounds for all the special purposes for which they may be required.

THE CHUQUICARA RAILWAY OF PERU.

Work was commenced in July of last year on the construction of the Chuquicara Railway, a branch of the Chimbote Railway, which, leaving this line at 75 kilometres, will run in a northerly direction up the valley of the Chuquicara River, with its immediate objective, the Ancos coalfields, 25 kilometres (15½ miles) distant. Ultimately, the line will pass within about 30 kilometres of the Magistral copper district, through the town of Santiago de Chuco, within 10 kilometres of the Chimborazo copper deposits, and through the towns of Huamachuco and Cajabamba. This region and that lying still further to the northward is one of the richest mineralised sections of Peru.

The contractors for the construction of the section from Chuquicara to Ancos expect to complete the work by the beginning of 1921. According to a report by the United States Vice-Consul at Callao-Lima, the Chuquicara Railway is typically a mountain railway. There are four tunnels in the first 10 kilometres, and 27 retaining walls in one 3-kilometre section. One section of 4 kilometres is said to equal the most difficult section of the Central Railway, and preliminary work is being carried on with men suspended from ropes over the mountain walls.

The abutments of the bridge to be built over the Santa River at Chuquicara have been completed. The bridge will have a length of 131 ft. Like the Chimbote Railway the gauge of the Chuquicara branch is 91 centimetres, but the permanent way is being adapted to normal gauge in the event of it becoming desirable to alter the gauge in the future.

The financing of this extension is being carried on by the Government with a portion of the revenue from the tobacco monopoly. The entire revenue of this monopoly was allocated to railway construction by the railway law passed in 1918.

The Ancos coal deposits which will be reached by the Chuquicara extension are semi-anthracite, averaging roughly 78 per cent. in fixed carbon, 14 per cent. volatile matter, and 8 per cent. ashes. It is used in place of coke by some of the mines in this region, though coke is of course preferable. All of the coal claims in the Ancos deposit have already been taken up.

GENERAL NOTES.

JAPAN AND THE RESTRICTION OF ARMAMENTS.—In a recent issue of the *Proceedings* of the United States Naval Institute there are printed translations of a number of articles which have appeared in the Japanese press on the subject of that country's "eight-and-eight" naval building programme, and discussing her position—for, as a member of the League of Nations, Japan has signed the covenant recognising the necessity for the reduction of armaments. The Tokio *Jiji*, a pro-Government organ, states that Japan's naval programme is not new but dates back to a time shortly after the termination of the Russo-Japanese war. At that period, the scheme known as the "eight-and-eight" fleet (eight battleships and eight battle-cruisers) was generally recognised by specialists to be the minimum limit of Japan's naval equipment, and if it had not been for financial or political obstacles the plan would have been completely carried into execution several years ago. Accordingly, it is thought that Japan can increase the "eight-and-six" fleet (actually in process of making) into an "eight-and-eight" fleet without provoking the suspicions of other Powers. The opinion of the Japanese Navy Department in regard to the question of the limitation of armaments seems to be as follows: It is understood by every Power that Japan has a special position in the Far East, and is charged with the responsibility of preserving the peace of the Orient. Secondly, Japan is justified in aiming at an "eight-and-eight" standard because during the war all European nations extended their armaments, but Japan was not able to achieve even the pre-war minimum—therefore it is impossible for her to reduce her programme. Japan has no aggressive purpose, but the "eight-and-eight" programme is a minimum for meeting her responsibilities in the Far East and ensuring her self-defence.

THE FOUNDATION OF AN INSTITUTE OF PHYSICS.—The need has long been felt for a corporate body, analogous to the Institute of Chemistry, which would represent the profession and strengthen the position of workers engaged in physics, and which would also form a bond between the various societies interested. At present the physicist is hardly recognised as a member of one of the professions, but the vital importance of many developments of physics during the war and the certainty of its growing importance, both in science and industry, are bringing about a change in this respect. It is one of the aims of the new Institute of Physics to secure recognition of the position and value of the physicist, and it is felt that such recognition can only be obtained by the co-operative action of all the physicists in the country. The Institute has been founded by the co-operation in the first instance of The Faraday Society, The Optical Society, and The Physical Society of London, and the first Board is constituted from representatives appointed by the Councils of these Societies. It is hoped that in the course of time other Societies will associate themselves with the Institute. Members of the Institute who are also members of more than one of the co-operating Societies will obtain a reduction to the subscription to those Societies. There will be three classes of members: Ordinary Members, Associates (A.Inst.P.), and Fellows (F.Inst.P.). Only the two latter classes, membership of which will require full professional qualifications, will be Corporate Members. The Institute has already received promises of support from leading physicists, and the initial expenses are covered by a Guarantee Fund amounting to over £1,200. The first President of the Institute is Sir Richard Glazebrook, K.C.B., F.R.S., Sir Robert Hadfield, Bart., F.R.S., is Treasurer, and Professor A. W. Porter, F.R.S., Honorary Secretary. The other members of the Board are: Dr. H. S. Allen, Inst. Commander T. Y. Baker, R.N., Prof. F. J. Cheshire, C.B.E., Dr. R. S. Clay, Mr. W. R. Cooper, Prof. W. H. Eccles, Major E. O. Henricé, Dr. C. H. Lees, F.R.S., Mr. C. C. Paterson, O.B.E., Major C. E. S. Phillips, Dr. E. H. Rayner, Mr. T. Smith, and Mr. R. S. Whipple. Mr. F. S. Spiers has been appointed Secretary to the Institute, and further particulars and Forms of Application for Membership may be obtained from him at 10, Essex Street, Strand, W.C. 2.

Belgian Railways.—At the beginning of last year, according to the *Railway Gazette*, the total number of Belgian locomotives actually fit for service only amounted to 279. By the end of 1919 this number had risen to 2,700. The effect of this increase was to make it possible to operate 50 per cent. of the pre-war passenger service and 65 per cent. of the pre-war number of goods trains. In addition, 675 new locomotives were ordered last year. Altogether, 9,400 passenger vehicles and 57,800 goods wagons of various types were repaired during the year, and 9,000 new wagons were ordered. Perhaps the most striking fact in the whole of the year's working was that in December, 1919, it was possible to run some 1,100 goods trains a day, which is forty times the number operated in January of the same year.

Portable Houses for Seville.—According to the American Consul in Seville, rents have become so high that many poor people are forced to leave the city, and it is felt that the demands for higher wages would cease, or at least be reduced, if labourers could find houses at a moderate rental. As there is practically no lumber in Spain for building wooden houses, and the expense of constructing them of brick is prohibitive, it has been suggested to the civil authorities that portable houses might be imported from the United States. The city owns a large tract of land along the Guadalquivir River, and it is planned to erect houses of from two to four rooms on this property for the use of the labourers, the occupants paying rent to the city for the use of these houses. At present a thousand such houses are being considered, although more will probably be needed later.

MEETINGS OF THE SOCIETY.

Indian Section.

Friday afternoon, at 4.30 p.m. :—

June 18.—Sir Valentine Chirol, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.) The Right Hon. Lord Meston, K.C.S.I., LL.D., will preside.

Cantor Lecture.

Monday evening, June 7th, at 8 p.m. (lecture postponed from April 26th) :—

Walter Rosenhain, B.A., D.Sc., F.R.S., Superintendent, Department of Metallurgy, National Physical Laboratory, "Aluminium and its Alloys." (Lecture III.)

Syllabus.

Special Uses of aluminium alloys—Castings for automobile and aeroplane parts—Castings for aero-engines—Pistons and piston alloys—Properties at high temperatures—Automobile and aero-cylinders—Other engine parts—Structural uses—Rigid airships, aeroplane spars, and wing-coverings—Possible future developments.

MEETINGS FOR THE ENSUING WEEK.

Monday, June 7 ... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. (Cantor Lecture.) Dr. W. Rosenhain, "Aluminium and its Alloys." (Lecture III.)

Chemical Industry, Society of (London Section), at the Chemical Society, Burlington House, W., 8 p.m.

Geographical Society, 135, New Bond-street, W., 8.30 p.m. Professor Dr. G. A. F. Molengraaff, "Ocean Research in the Dutch East Indies."

Tuesday, June 8 ... Colonial Institute, Central Hall, Westminster, S.W., 8 p.m. Miss F. B. Lysnar, "New Zealand."

Wednesday, June 9 ... University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Professor A. J. Toynbee, "Egypt and Mesopotamia (Fourth Millenium to Sixth Century B.C.)."

Geological Society, Burlington House, W., 5.30 p.m. Dr. C. G. Knott, "Earthquake Waves and the Elasticity of the Earth."

Electrical Engineers, Institution of (Wireless Section), at the Institution of Mechanical Engineers, Storey's-gate, S.W., 6 p.m. Mr. M. M. Latour, "High Frequency Machines."

Thursday, June 10...Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Mining Engineers, Institution of, at the Geological Society, Burlington House, W., 11 a.m. 1. Professor H. Louis, "Compensation for Subsidences." 2. Mr. W. Maurice, (*a*) "The Fleissner Singing-flame Lamp." (*b*) "The Wolf-Pokorny and Wiele Acetylene Safety-lamps." 3. Mr. G. Oldham, "The 'Oldham' Cap Type Miner's Electric Safety-lamp." 4. Discussion on papers already published: First Report of the Committee on "The Control of Atmospheric Conditions in Hot and Deep Mines." Mr. D. S. Newey, "A New Method of Working Thick Seams of Coal at Baggeridge Colliery." Mr. T. G. Beckins, (*a*) "Protractors." (*b*) "Magnetic Meridian Observations: A Method of Utilising the Kew Observatory Records."

Metals, Institute of, at the Institution of Mechanical Engineer's, Storey's-gate, S.W., 8 p.m. Professor C. A. F. Benedicks, "Recent Progress in Thermo-Electricity."

Optical Society, at the Imperial College of Science and Technology, South Kensington, S.W., 7.30 p.m. 1. Miss A. B. Dale, "Accuracy of Setting." 2. Dr. J. S. Anderson, "A New Method of Immersion Refractometry."

Historical Society, 22, Russell-square, W.C., 5 p.m.

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 7.30 p.m. Mr. E. L. Joseph, "Ventilation and Air Purification as applied to Modern Concrete Buildings."

University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Captain A. N. J. Whymant, "Chinese Customs and Etiquette."

Friday, June 11 ... Malacological Society, at the Linnean Society, Burlington House, W., 8 p.m.

Astronomical Society, Burlington House, W., 5 p.m.

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

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FRIDAY, JUNE 11, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

FRIDAY, JUNE 18th, at 4.30 p.m. (Indian Section.) SIR VALENTINE CHIROL, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.) The RIGHT HON. LORD MESTON, K.C.S.I., LL.D., will preside.

INDIAN AND COLONIAL SECTIONS.

FRIDAY, JUNE 4th; THE RIGHT HON. E. G. PRETYMAN, M.P., in the chair. A paper on "The Oil Resources of the British Empire," was read by PROFESSOR SIR JOHN CADMAN, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E.

The paper and discussion will be published in a subsequent number of the *Journal*.

CANTOR LECTURE.

On Monday evening, June 7th, DR. WALTER ROSENHAIN, D.Sc., Superintendent of the Department of Metallurgy and Metallurgical Chemistry, National Physical Laboratory, delivered the third and final lecture of his course on "Aluminium and its Alloys."

On the motion of the CHAIRMAN, Engineer Rear-Admiral SIR GEORGE GOODWIN GOODWIN, K.C.B., a vote of thanks was accorded to Dr. Rosenhain for his interesting course.

The lectures will be published in the *Journal* during the summer recess.

EXAMINATIONS.

The results of all stages of the examinations held from March 22nd to 31st have now been sent to the centres concerned.

In the Advanced Stage 1642 papers were worked. Of these 237 were awarded first-class certificates, 656 second-class certificates, and 749 failed.

In the Intermediate Stage the number of papers worked was 5,108, with 677 first-class and 2,650 second-class certificates; the failures numbered 1,781.

In the Elementary Stage 9,496 papers were worked. The passes numbered 6,103, and the failures 3,393.

In 1921 the first, or Easter, examination will commence on Monday, March 14th, and will finish on Wednesday, March 23rd. The second, or Whitsuntide, examination will commence on Monday, May 2nd, and finish on Wednesday, May 11th. Detailed time-tables will be issued shortly.

PROCEEDINGS OF THE SOCIETY.

EIGHTEENTH ORDINARY MEETING.

WEDNESDAY, APRIL 28th; The Right Hon. LORD DESBOROUGH, K.C.V.O., in the chair.

THE CHAIRMAN said it was his privilege to introduce the lecturer, Brigadier-General Charles H. Sherrill, who was to lecture on a most interesting subject. His inducement to take the Chair on that occasion arose more from his personal connection with Brigadier-General Sherrill than from the subject of the paper. He had had the pleasure of meeting the lecturer when he was doing very good work at the International Chambers of Commerce in Paris the year before the war; and he knew him as one who did excellent service in training some considerable portion of the huge army which eventually sailed from America. He had devoted a life-long study to the subject of stained glass, and had written at least two books on the subject, "Stained Glass Tours in France" and "Stained Glass Tours in England." He might mention that he himself had had some beautiful stained glass which had been taken out of the old manor house of Ockwells in the county of Berkshire, and he had had the privilege of giving that stained glass to be put back into the old manor house when it was restored. His joy in being able to do that was somewhat tempered later on, when a dealer told him that he would be very pleased to offer him £24,000 for the glass. It consisted largely of old

coats-of-arms, one of them being the arms of Henry VI.; and as Henry VI. was deposed somewhere about 1461, the chances were that the glass dated back even before that period. Most people were interested in stained glass, and he thought the Society was very fortunate to have someone who could speak on stained glass with so much knowledge, authority and enthusiasm as the lecturer.

The paper read was—

A STAINED-GLASS TOUR.

By Brigadier-General Charles H. Sherrill, LL.D., of New York.

It is rather as a traveller, a mere sightseer, that I should come before your honourable Society to-day, and not as one laying claim to any especial knowledge of the charming craft whose product we call "stained glass." The books I have written upon English, French, and Italian glass have been meant only as guide-books, intended to facilitate and encourage the viewing of fine old windows, not only by those already interested therein, but also by others who, finding tours laid out for them all ready to hand, might thereby be induced to see for themselves some of the beauties left to us by the window-makers of the Middle Ages. So glorious are those combinations of colour and light, that I am convinced that if only more people could be enticed to look upon them, their inherent charm would so lay hold upon these casual observers as to make them as devoted enthusiasts as I myself have become.

In that spirit let me come before you to-day, asking you to accompany me upon a stained-glass tour, which, I hope, will prove but a preliminary to more extended ones by not a few of my hearers. We will cross the Channel several times, for, alas! like true love, the course of ancient glass never did run smooth in either England or France. Italian glass began much later than the French, ripened more quickly, and ended earlier; while in Germany the craft, beginning early, developed methodically with no serious interruptions, and ended late. We will begin by looking at some twelfth and thirteenth century examples of the *peintres-verriers'* art in France, where those two periods produced so many and such fine examples of their art, whilst little or none was being made on this side of the Channel.

Those artistically fruitful years were followed in France by the dark days of the fourteenth and fifteenth centuries, when the so-called Hundred Years' War so long outlasted its title, and when the constant harrying of France by English forces, combined with plague and uprisings of peasantry, checked the output of such artistic luxuries as stained-glass windows. But, fortunately, both for us and the craft, we need only return across the Channel to find here in your island home a veritable outburst of coloured windows, lasting all through the fourteenth and fifteenth centuries, changing in expression, however, as your architecture developed through the budding and blossoming of your decorated and perpendicular styles.

By the time the sixteenth century arrived, your glass men would seem to have shot their bolt, and to have almost ceased from practising their profession, so slight is their output thereafter. The Renaissance, so vitalising a movement on the Continent, did not seem to show such a compelling revival of art initiative with you as it did with the French, which, perhaps, is but natural, for the Italian wars of Louis XII. and Francis I. had not only shown their soldiery the ancient glories of Italian art, but had also, through the trophies they brought home with them, fired the imagination of French artists in all fields of production. You lacked these military missionaries of classic art, and therefore we must once more leave England and cross the Channel to follow our studies. Again, the crossing will be rewarded by sight of a wealth of windows, but this time entirely classic and no longer Gothic in their detail and feeling. With all that France can rightly boast of its triumphs in sixteenth century Renaissance stained glass, plus a few English windows, we will end our rambles. After all, five centuries make rather a long journey for one afternoon; indeed, I can only hope your patience will endure till its close.

So markedly did the different styles of glazing alter with the changing centuries or periods, that it needs no profound student to recognise the approximate date of a mediæval window. During the sixteenth century, the French glaziers had the obliging custom of dating their work, either quite openly or else with artistic coquetry—as in the case of a window at Les Iffs, where the date is marked on a coin held by one of the figures. Heraldic blasons, so much more frequent in England than in France, are very helpful in fixing not only the time of manufacture, but sometimes even more than that, for it is the shields set out upon Gloucester Cathedral's East window that tell us that it commemorates those gallant English knights who fought at Crécy. Because the St. Edmund

window in Bristol Cathedral shows the arms of Humphrey de Bohun, Earl of Hereford, slain in open rebellion in 1322, and does not bear those of Piers Gaveston, murdered in 1312, we can safely date the glass somewhere between those occurrences, say 1320. Because in one of the towers of Knole, that delightful and stately home of old England, a morsel of glazing, high up in a tracery light, shows the double bowknot of Bishop Bourchier of Canterbury, we know that this portion of the ancient pile is at least as old as his tenancy there, which was 1456–86. Blasons are not so helpful in France, both because their heraldry was not so precise as the English, and also because an edict in 1792 caused the destruction of many of them. And this destruction was continually going on through the centuries, sometimes chargeable to misfortune alone, but frequently to deliberate act. The Huns near Rheims have not been the only vandals from whom this handicraft has suffered. Aubrey's "History of Surrey" records that during the Reformation "one Blesse was hired for half a crown a day to break the painted glass windows of Croydon." At Lincoln the citizens practised shooting with the cross-bow at the Cathedral's windows, while at Great Malvern they quite simply threw stones at them! As early as 1330, the Commune of Assisi had to impose a fine of five lire for throwing stones at their great church's windows. When Rome was besieged by the Bourbon in 1527, its numerous ancient windows were broken up to get their wealth of lead for bullets. And sometimes peace was as destructive as war, for when Charles V. was being crowned Emperor by Pope Clement VII. in Bologna Cathedral, the salvoes of artillery broke much of its old glass. At Salisbury, during Wyatt's ruthless restoration, we read that "whole cartloads of glass, lead, and other rubbish were removed from the nave and transepts and shot into the town ditch, then in course of being filled up; whilst a good deal of similar rubbish was used to level the ground near the chapter-house." It is somewhat consoling to learn that in 1632 the Recorder of Salisbury, found guilty of destroying the Creation window in St. Edmund's Church (in order, forsooth, to let in more light!), was imprisoned, fined £500, and made to apologise to the Bishop of Salisbury. After reading the boast of "Blue Dick Culmer," the Minister at Canterbury Cathedral during the Commonwealth, of his "rattling down proud Becket's glassie bones with a whole pike in his hand, when others present would not venture so high," we may be pardoned the anachronistic wish that the knights who slew Becket there had chosen Culmer instead.

Glass of the twelfth and thirteenth centuries was made up of much smaller bits than are later seen, and because this meant, to hold them in place, a labyrinth of light-obscuring lead lines, and also because even uncoloured glass was then less translucent than it is to-day, dimly lighted interiors were the natural result. The little figures that peopled the panes in those early days were collected together in groups within borders shaped like medallions, so this orderly arrangement resulted in their type being called "medallion glass." English medallions tended to be smaller than their French cousins, because Early English lancets were narrower than contemporary French embrasures. In Italy the medallions were more varied and fantastic in their shapes than in either England or France. Sometimes this glass is called mosaic, because made up, as is mosaic, of such small bits of glass. Thirteenth century glass is famous for its jewelled glitter, caused by the diminutive panes breaking up and combining the rays of light. This was not the result of chance, for in the twelfth or preceding century the pieces of glass were distinctly larger, which, of course, meant correspondingly less labour in winding about the supporting leads. Perhaps the finest of all the very early windows is just on the right as you enter the nave of Le Mans Cathedral.

(1*) Note the early Norman arch to the window embrasure, and the very broad border then customary. In England, the round Norman arch over a broad embrasure soon gave way to the Early English lancets, narrow and pointed at the top. In these latter, only narrow borders were possible.

(2) Closer inspection reveals that this scene is the Ascension. The drawing on these very early windows is so exactly like that on contemporary enamels and on mosaics, and stained glass begins as such a finished art, that there is no doubt it owes much to the enamel draughtsmen and to the earlier ones of mosaic. These very panes were among those that softened the light falling upon the baptism of your Henry II., for it was in this church that in 1133 Henry Plantagenet was christened, and we know that this glass was already in place, for it was the only window that survived the great fire of 1120.

(3) Next we see a bit from the oldest known

* The figures refer to the slides thrown on the screen.

window of St. Denis Cathedral, in whose vaults lie entombed so long a line of early French sovereigns. The abject figure at the bottom is Abbot Suger, who gave the window. Later on the donors grew to be far less modest. Note the bands of lettering, done by scratching upon blackened strips of glass. At this time the glass was coloured through and through in the pot, and is called pot-metal glass. Surface pigment was used only to delineate the features, and occasionally to bring out folds of garments. This pot-metal glass persisted much later in Italy than elsewhere.

(4) This other early St. Denis panel shows a Tree of Jesse, a design whose popularity endured throughout the entire life of mediæval stained glass. The vine springing from the loins of Jesse becomes more and more ornate as the centuries advance. Notice that we have here a much-peopled border, which was infrequent except in the case of Jesse windows. The lower right-hand figure was the donor of the window, and he holds its model in his hand, as was often customary.

(5) This glimpse of the choir chapels in Bourges Cathedral gives some idea of the lighting effects produced by medallion glass, truly "a dim religious light," which is here as excellently displayed below as, above them, greater illumination is afforded by the long row of forty-five small roses and the stately garrison of tall single figures.

(6) This Chartres window shows how the glazier combined different shapes of medallions so as gracefully to complete his space composition. The interstices he filled with what is called strap-work, generally of red and blue bits, so interwoven together as to produce a grape-juice purple, more mellow in colour than a single pane of purple. The four thousand figures on the 174 windows here still filled with their original thirteenth century glazing, tell in the minutest detail the life of the time. The windows along the nave aisles were presented by different trade guilds of the city, and fully set out their life and occupations. If the gorgeous set of thirty-six kings that used to adorn the Rheims clerestory justified its title of Royal Rheims, then surely at Chartres this glass, pulsating with colour, preserves for us the great heart beat of the mediæval middle classes.

(7) Angers Cathedral is especially interesting for the glass sightseer because he can there, more readily than anywhere else, compare the larger pieces of these twelfth century windows in its nave with the tiny-morselled ones of the thirteenth century in the choir, and see for himself how the latter glisten and glitter, while the early ones show but flat colour, warm in tone though it be.

(8) When Louis IX. (St. Louis) succeeded in obtaining a fragment of the true Cross, no more suitably sumptuous a receptacle could he imagine for it than a sanctuary whose walls should be sheets of light-admitting colour, and so there was built for him in three years' time (1245 to 1248) the Sainte Chapelle of Paris, where to-day it stands protected from the modern street life of that gay capital by the serious buildings of the Law Courts. This bower of light steeped in colour should be visited on a cloudy day, for the pursuit of stained glass is as truly a rainy day sport as is that beloved of Izaak Walton and other fishermen. On a sunny day the glass towards the sun will seem thin in colour, while that on the shady side will be dull and flat-toned.

(9) The north rose of Notre Dame is not only a *chef-d'œuvre* of lacelike stone-work and of design, but also very deceitful in its colouring, for although, thanks to the deft juxtaposition of its red and blue panes, it is a purplish window, it really contains no purple glass. Frequently these great wheels of light and colour enjoyed pleasantly familiar names. At Amiens the westerly, northerly, and southerly ones are called the Rosace of the Sea, of the Winds, and of Heaven respectively. The northerly one at Chartres is the Rose of Heaven, while at Lincoln the two roses are called the Dean's Eye and the Bishop's Eye. The skillful wall-adjustment of these great rosaces in French cathedrals is most delightful, and frequently, as here at Notre Dame, the giant wheel is balanced below by a gallery of sturdy worthies of the past.

(10) Such a line is to be seen just below the northern rosace of Chartres Cathedral. Note that in the early faces the glass is not white but brownish, making these gentry appear rather too sun-burned for Caucasians. This tint was better than would have been the untinted glass of the period, for it was not white but greenish. These great figures, "like watchmen on a leaguered wall," were frequently stationed around French clerestories during the thirteenth century, and served the useful purpose (by reason of their larger pieces of glass, and therefore less leads) of letting in from above much more light than was permitted below them by the mosaic medallion panes.

(11) The graceful symmetry of the Sens

Cathedral medallions is completely satisfying. It is no wonder that Thomas à Becket fell in love with them! We make this rash assertion confidently, for we know that he lived in Sens from 1166 to 1170. Pope Alexander III. spent two years at Sens immediately before that, and therefore both these famous churchmen saw the great architect, William of Sens, there developing the pointed arch, which meant the new Gothic architecture to all those church dignitaries who came thither from all over Europe to visit the Pope, and returned home to spread the gospel of Gothic. Later, in 1174, when the choir of Canterbury Cathedral was rebuilt, William of Sens was brought over to supervise the work, and the unfortunate architect met an untimely end by falling from a scaffold before his task was completed.

(12) That William brought his glassmen over with him needs but a glance at the early Canterbury windows to reveal. In those below and around "Becket's Crown," at the extreme easterly end of the choir, we see blood-sisters of those in the Sens choir chapels, and always the same well-balanced disposition of the medallions within their borders, which will continue broad in the French manner until the wide Norman windows yield to the narrower Early English lancet. These windows date from the middle of the century.

(13) A closer examination of the detail in these medallions shows spirited action on the part of their small inhabitants, and from them much is to be learned of the customs of their day.

(14) On the north side of Canterbury Cathedral's Trinity Chapel there is a very simple arrangement of the stories up and down the panes. It makes quite a human touch in Chaucer's "Canterbury Tales," when he has his pilgrims, as soon as ever they have entered the cathedral, fall to studying out the legends on the glass. His choice of title for this poem was a shrewd one, for he knew well how very many folk all over the kingdom had made this pilgrimage, and would therefore wish to read his "Tales."

(15) Quite different and particularly graceful is the fanlike adjustment of the panels employed on this chapel's southerly side, and one far from easy to compass. The mellow richness of the old reds and blues here are delightful.

(16) Although this chapel is not of sufficient width to allow the spectator to enjoy the glitter of the early glass, which needs a greater distance to develop, a recompense is found in the opportunity for close inspection and study of the Bible stories nowhere else surpassed. We cannot do better than follow the example of Chaucer's sightseeing pilgrims.

(17) At the very top of one of these windows there appears the only extant picture of the famous golden shrine, which contained the martyred prelate's mortal remains. It shows the saint issuing from the left end. So highly was this shrine venerated, that we are told that during the Jubilee of 1420 no less than one hundred thousand pilgrims visited the city in one day, and their gifts to it totalled a huge value. We know that so late as Henry VIII.'s time, he was able to find and seize twenty-six cart-loads of booty from about the shrine. It is a striking comment upon the charmed life borne by this glass that, notwithstanding its fragility, it should have preserved the only picture of this world-famous shrine. It must have been a true likeness, for it was so close to the original that any but a careful copy would have failed to tell its story to the pilgrims.

(18) One of the greatest glories of glass anywhere in the world is the group called "The Five Sisters," at York. That city, whose Minster alone contains over 25,000 square feet of ancient glazing, ranks with Rouen and Troyes as a great glass centre, and, like them, has many examples from each of the centuries when the art was at its best. These "Five Sisters" are of a type called *grisaille*; they told no story like those of the medallion type, but, on the other hand, they did not obscure so much light, and were therefore more practical. In England, your glaziers were fond of relieving the monotony of the *grisaille* panes, not only with occasional glimpses of colour, but also by outlines of plants, leaves, or vines. Here we have the leaves of the benet plant. There was also much fine old thirteenth century *grisaille* in Salisbury Cathedral, where, you will remember, there was a window for every day in the year, a door for every month, and a pillar for every hour. Old Thomas Fuller called it "an almanac of architecture."

(19) Another whim of these early artists was to use tints which, though seemingly inappropriate, were nevertheless so deftly adjusted to the general colour scheme as to be entirely satisfactory. Many a visitor to Poitiers Cathedral has gone away without realising that, in its gorgeous Crucifixion window, the cross is red and the hair of the Saviour blue! I know a sixteenth century window by Marcillac, in Arezzo, where the clouds are pink, but one does not notice it, so ingeniously readjusted is his

colour scheme. Figures as large as this one at Poitiers and as those at Chartres, were stationed along the clerestory lights of Rheims Cathedral, representing the first thirty-six kings of France, while just below each was the Archbishop who crowned him. On July 1st, 1429, these ancient worthies, already two centuries old, looked down upon the coronation of Charles VII. with Joan of Arc hard by. This splendid series were destroyed by the Huns, as were also the fine old windows at St. Quentin. Even that cold-blooded brute, Philip II. of Spain, when besieging St. Quentin in 1557, had decency enough to order his artillery to avoid breaking the ancient glass; but he only spared it for a later destruction by the "kultured" Prussians.

(20) While in Poitiers one should visit the church of St. Radegonde, not only because of its interesting glass, but because we can there study the transition from the thirteenth to the fourteenth century styles. The borders now become narrower, coloured medallions are being placed upon *grisaille* backgrounds so as to admit more light, and the upper part of the window is receiving more consideration, and therefore more graceful treatment. The figures on this window, taken together, form a picture of the Last Judgment.

(21) Speaking of better lighted interiors, it is to Troyes and its dainty eggshell of a church, St. Urbain, that one must go for perfection in this regard. Once upon a time there was a son of a modest shopkeeper there, named Jacques Pantaléon, who, marvellous to relate, became Pope of Rome. He never forgot his birthplace far away to the north, and there upon the site of his father's shop he caused to be erected, in 1263, a church with walls of stained glass supported by innumerable flying buttresses—one of the marvels of moyenage architecture. Here we have medallions to tell their sacred stories, but surrounded by fields of *grisaille* flooding the place with light.

(22) In the Cathedral of Troyes one finds the medallions in all their glory completely monopolising the choir chapels. They are of a richness one might expect in a city where all Europe yearly assembled for one of the greatest fairs of the Middle Ages—a fair of such significance in luxuries as to have embalmed it in our phrase "troy weight," still used by modern jewellers. Troyes windows became so widely known that one of them, a nave clerestory light from the Church of St. Jean, was demanded as part of the ransom of Francis I. after his capture at the battle of Pavia.

(23) Tours Cathedral is another in which one can study the product of the closing years of the thirteenth century. The borders are now distinctly narrow, and even then sometimes the medallions intrude upon them. This feature is best studied at Coutances in Normandy. The interior at Tours always impresses one as unduly narrow, and the reason is that the architect did not here avail himself of the usual device of slightly increasing the interior's width as the walls rose, done to offset the gradual contracting of the perspective to one looking up from below.

(24) Although our visit to France is now drawing to a close, because, with the arrival of the fourteenth century, there will be little in France to compare with its wealth of windows in England, the Cathedral of Sées and the great church of St. Ouen at Rouen will repay a visit before embarking for England. St. Ouen is almost completely glazed in one style, and the harmonious whole is most agreeable.

(25) Within the medallions and above the small figures we have, perhaps, all along been noticing little roofs, rather sketchy, but serving to indicate that the scene was indoors. These roofs are destined to develop and play a great part, not only in the drawing of our subjects, but also in the manufacture of the glass and in the amount of lighting it permits. At St. Ouen one sees pinnacles appearing above the people—of course, in the Gothic style then prevailing. Notice that there are as yet no pedestals, and that the figures and their canopies (as these sentry-box structures are called) do not yet aspire to fill the entire window space.

(26) Indeed, at St. Ouen, the canopy is still so unimportant a factor in glazing, that it is sometimes entirely omitted and the coloured figures set quite frankly against a *grisaille* background. Nowhere will we find so complete a series of patriarchs, saints, apostles, bishops, and abbots. It is not surprising that the English should at that time have so greatly admired French glazing. Five hundred square feet of French glass was brought over for Exeter Cathedral in 1302–4, and when more was needed in 1317, they sent to Rouen for it. Nor was this a passing fashion, for the contract to glaze Beauchamp Chapel, Warwick, made in 1447 by the Earl's executors with John Prudde of Westminster requires that there be used "Glasse from beyond the seas and no Glasse of Englande," so Prudde fetched his material from France.

(27) At Tours we will see an un-French sort of fourteenth-century window, for it is rich in

colouring like its contemporaries across the Channel, where no revulsion from the dim interiors of the fourteenth century had been necessary, because English skies had early taught the need of an adequate amount of *grisaille* to admit light. While the French, early in the fourteenth century, swung abruptly to light tints, deepening as the fifteenth century came on, the English (not needing the lighting reform) developed naturally from still strong hues inherited from the thirteenth century on through the fourteenth century, to lighter ones in the fifteenth. In sunny Italy deep colour continued throughout.

(28) Merton College, Oxford, has its chapel glazed entirely in the early fourteenth-century manner, and there the richly coloured figures within equally gay canopies are carried in one great band all around the interior, with much *grisaille* both below and above them, while at the top, the windows reach a handsome culmination in a style that truly deserves its name of "Decorated." These tracery lights were needed as a balance above to the groups of lancets below them, which by this time had come to replace the single lancet of the Early English period.

(29) The balance of colour and light in this work, provided an entirely satisfactory interior lighting. We are now coming to a period when a pane often had one colour on one side and another on the other. The French were experts at this and called it *verre doublé*, or lined glass. It was effected by re-dipping a partly blown bubble of glass into a pot containing liquid glass of a contrasting hue—for example, red into blue or yellow into red. When the bubble was cut open and held up to light, the effect of the first combination would be purple, and of the second orange. This process had always been used for red glass, the ruby being always thinned down in tone by a coat of uncoloured glass. Nor were the French contented with but two layers, for I know a fifteenth-century pane at Quimper, down in Brittany, that has six such layers or coats of glazing.

(30) Note the labels starting in front of the faces and swinging gracefully over the head and down the back. The decorative possibilities of these written scrolls or labels were nowhere so well worked out as in Germany. Sometimes one encountered written music similarly introduced, as at Warwick, and at Conches and Caudebec in Normandy.

(31) The treatment of the great East window in Merton Chapel is very pleasing, and this will remind us that, although the huge rose windows of France are for beauty and number unrivalled elsewhere, England may be equally proud of her wealth of splendid East windows. Their great expanse and the beauty of their treatment are as distinctively English as are the great wheel windows, French, or the unencumbered circular apertures called *ochio* (eye window), Italian, or windows showing great depth to their interpenetrated architecture, German.

(32) To visit a bower of light that rivals the Sainte Chapelle of Paris or St. Urbain at Troyes, we must return to York Minster and penetrate to its handsome octagonal Chapter House. Here one sees a glazing that perfectly suits the cloudy skies more frequent in this northern district than in sunny France. The east end of the small Dorchester church near Oxford is the nearest rival of the Chapter House in point of lighting. There the stone mullions of the window bear figures which, together with those upon the glass, make up a Tree of Jesse, the mullions themselves serving as the vine. The use of window mullions for this purpose here is as unique as is the woolen frame-work of a house in Joigny, France, likewise depicting a Tree of Jesse.

(33) This York Minster Chapter House dates from the time of Edward II. and III. Your "Decorated" period can show nothing better than the treatment here of the window tops, destined later, in the "Perpendicular" period, to lose their individuality and become stiffly regular and part of the window below them.

(34) The glazier has here employed four bands of late medallions in colour drawn across a field of *grisaille* enlivened with occasional touches of red and blue. This *grisaille* leans to grey rather than to the more usual greenish hue, and moreover, the quarries are cut into irregular shapes, less monotonous than the commoner diamond panes.

(35) No less delightful than the lofty brightness of the Chapter House itself, is the charming L-shaped vestibule leading thereto, entirely glazed at the same time and in the same manner. Its tall lancets are crowded with archaic figures and crude canopies.

(36) Very early in the fourteenth century there occurred a chance discovery destined to revolutionise glazing. In some way (and many claim the credit) it was found that chloride of silver, melted and dropped on glass, would colour the surface golden at that point. This was called yellow stain, and was promptly employed to depict hair, especially of angels, to enrich costumes, etc. But most important

was the effect it had upon the development of the canopy, for no longer was it necessary to lead in bits of yellow glass where needed, and therefore the simulated stone structures could be much more easily enlivened and extended by yellow stain than was theretofore possible. It is upon the Bell-founders' window, along the north aisle of the York Minster nave, that there appears the earliest use I know of yellow stain. Winston dates this window 1306 or 1307.

(37) A closer examination shows many pleasing details, among others the appropriate use of bells, so frequent throughout the border. This window, perhaps the finest of its type in all England, was the gift of Richard Tunnoc, Lord Mayor of York, who died in 1330. Above his effigy appears a small picture of the window.

(38) The fine West window, 56 ft. high by 25 ft. wide, presented in 1338 by Archbishop Melton, is as elaborate an example as the "Decorated" period can show of tasteful curvilinear elaboration of a window top. It should be noted that all the nave's aisle embrasures but two, and also all but two of its clerestory ones, retain their original glazing. Indeed, we have here the most extensive remains of English work of the early fourteenth century.

(39) The Lady Chapel of Christ Church, Oxford, shows a considerable advance in the "Decorated" period over what we recently saw at its neighbour, Merton College, for here the canopies are beginning to display a wider sweep and freedom, although still imposed upon a field of *grisaille*.

(40) The borders here are in agreeable proportion to the rest of the window, and the glazing of the tracery lights not so exaggerated as is often seen at that time.

(41) A similar treatment, but one more elaborate in design and richer in colour, is seen in that delightfully glazed sanctuary, Evreux Cathedral, in Normandy. Nowhere else at that time does the border receive so much attention. We have here a favourite French variation of *grisaille*, the so-called quarries, or diamond-shaped (*carré*) panels of uncoloured glass. They were not only easy to lead, but also their formal designs break up the surface agreeably, especially when touches of colour were judiciously introduced, which was often the case. Sometimes quarry windows were surcharged with gay heraldic blasons, but generally quarries filled in the space above and below the canopies, which as yet do not occupy all the lancet.

(42) Returning to York we find in the north wall of St. Dennis' nave an interesting example of an early "Decorated" canopy pushed tight up against the top of the lancet, forecasting how the glazier will presently come to fill the whole of its surface with his picture, and entirely exclude the *grisaille*.

(43) This complete filling of the window with the canopied figures is admirably exemplified in the Antechapel lights at New College, Oxford.

(44) These really mark the transition from the "Decorated" to the "Perpendicular" period, for although the canopies have sufficiently developed to have acquired pedestals and to fill the entire embrasure, there is still no perspective shown in their architecture, which is quite flat. Besides, the surface colour is not only smeared on with a brush in the "Decorated" manner, but also stippled on in that of the "Perpendicular" school. We see but a single figure within each canopy instead of the groups that will come later.

(45) The nave of St. Dennis Church, York, shows another advanced example of the "Decorated" canopy light, embellished by a rich border which was lacking at New College.

(46) No more elaborate minarets and spires are to be found in the canopies of this period than in the south-easterly window of St. Martin, Micklegate, York, even though they do not boast of pedestals. Notice that so insistent is the glazier that his *grisaille* shall admit its full quota of light, that the donors' figures thereon are only outlined instead of being full coloured as usual. These donors are going to grow in importance, until in the sixteenth century in France we shall find them unduly intruding upon the religious subject of the window, and even exceeding in size its principal personages. Indeed, at Montmorency, near Paris, Guy de Laval, the donor, occupies the central panel of the Crucifixion window; while at Champigny-sur-Veude, in Touraine, the chapel windows showing thirty-six kneeling donors, all members of the Bourbon Montpensier family, clearly prove how much more attention was then paid to such portraits than to the historical or religious subjects of the window. The English glaziers, however, never lost their sense of proportion in this regard. In Italy donors are almost never seen.

(47) A detail of the two right-hand panels here shows the church's patron saint dividing his cape, in strict accordance with tradition. This window is rendered especially brilliant by the generous use of red in the background.

(48) The south-east window of York Minster chancel is a gorgeous example of this period's

glazing, although the mullions of the tracery lights are not so fortunate in their form or their contents as some we have already seen.

(49) The most charmingly glazed of the many small churches of York is All Saints, or All Hallows, as it is sometimes called. Here to the left we can see the space below the "Decorated" canopied saint filled in with a small scene in colour, instead of the pedestal then coming into fashion. Note that the elaboration of uncoloured panes in the canopy tops on the left lets in as much light as does, on the right, the *grisaille* above the less developed canopies below. The right-hand window is, of course, earlier than the other.

(50) A detail from one of the northern lights here shows that perspective is now beginning to appear in the drawing of the canopy.

(51) But now it is time to turn from the "Decorated" to England's greatest period in stained glass, the "Perpendicular," lasting from 1380 to 1500, or from just before the last Plantagenet was succeeded by three Lancastrians and they by three Yorkists, until the accession of a Tudor (Henry VII.) marked the end of the War of the Roses. We shall remember as the chief characteristics of the "Decorated" period, the decorative treatment of the tracery lights, deeply rich colouring, the introduction of yellow stain, the development of the canopy but without a pedestal, glass with several layers of different colour, increased use of leaves, vines, etc., and shading smeared upon the surface. Now we come to shading which is stippled on, to increasingly lighter and softer tints in England (whilst an opposite tendency is seen in France), greatly elaborated canopies in both lands, and in England stiffly parallel mullions and loss of independence by the tracery lights. The most impressive of all this new period's product is the amazing East window at York Minster, 78 ft. by 32 ft. in expanse. Its only rival is that in Gloucester Cathedral, 72 ft. by 38 ft., commemorating the English knights who fought at Crécy. So huge is this York window that one hardly notices the gallery leading across the face of its 200 panels of figures. We know all about its construction, for the original contracts, dated 1405, are preserved and call for its completion in three years. It is no wonder that its citizens voted a tun of French wine to the Roundhead Fairfax for protecting their ancient windows when he besieged and took the city. No such decency was displayed by the Huns outside of Rheims, even though it was the best equipped city in the world for purchasing immunity with wine.

(52) At St. Martin's, Coney Street, York, the West window, given in 1447, shows an elaborately complete embrasure of "Perpendicular" construction, complete with the outswinging curved mullions in the traceries to avoid too monotonous an uprightness. Below, where the shadow of an adjoining building might have robbed the figures of their brilliancy or interest, the space is intelligently filled with elaborate quarries.

(53) The detail of this window repays inspection, as showing excellence of drawing and shading. This reminds us that opera glasses will frequently prove useful on stained-glass tours, and will reveal to us many of those quaint details in which mediæval artists revelled. For example, the golden tongues of flame in the Pentecostal window, or the Fall of Manna one at Montfort l'Amaury, near Paris, or the ruby glass used for the Red Sea through which the Israelites are crossing, at Caudebec near Rouen.

(54) We must not be kept from visiting All Soul's College Antechapel at Oxford by Prideaux's comment in 1674, that "it is a scandalous place and full of fast gentlemen." It has carefully drawn and coloured lights in the full "Perpendicular" manner. The pedestals have so much perspective as to make them very near to the German Interpenetrated style.

(55) Quite unique is the "Prick of Conscience" window at All Saints, York, showing under their squatty canopies the fifteen last days of the world as described by Richard Rolle, who died in 1349, while below are nine devout donors, kneeling in a row. The story begins at the lower left-hand corner and goes to the right, following the order usually then employed by glaziers. There are, of course, occasional exceptions to this general rule; as, for example, in the south choir aisle at Great Malvern, where, though the story develops from left to right, it begins at the top instead of at the bottom.

(56) Another famous window in this same church is one called "The Six Corporal Acts of Mercy," of which, perhaps, the most popular is the upper central one—"Giving Drink to the Thirsty." In its elaborate canopies and well-balanced scenes, this window is much more conventional than the unusual and catacomblike treatment of the "Prick of Conscience" window. In France this elaboration of light-admitting canopy reached such a point that at St. Lo they monopolise fully four-fifths of the entire embrasure, leaving but little for the solitary

saint in colour marooned in the midst of their shimmering magnificence. These windows were presented to the citizens by Louis XI. after their gallant repulse of the Bretons. In sunny Italy the canopy work continued to be done in strong rich tones, although this was, of course, partly due to copying the richly coloured marbles there so much used. On Marcillac's windows in Arezzo we see green malachite, red porphyry, polychrome marble, and much gaily coloured pavement.

(57) In the lowest central light of the East window of Holy Trinity, York, that sacred subject is depicted as three men each of about the same size, which is, so far as I know (and I have notes on over 20,000 windows) the only case of such a portrayal of the subject.

(58) St. Taurin, at Evreux, is another fine example of late fifteenth-century glazing, especially in the apse, for remember that in crossing the Channel we have robbed the glazier of the great flat expanse at the east end of English interiors, and that we are once more back in the home of the curved apse. Across the back of each canopy runs a richly decorated curtain, then rigorously required by the conventions. In the fourteenth century there was seldom more than one figure within each canopy, but now we have large groups of them. Some canopies here are very incongruously inhabited, as, for example, that group which shows the saint rescuing a lady from some sharp pointed flames while five smug onlookers piously approve the discomfort of the exorcised red imp.

(59) Perhaps the most ornate window of the entire period in France is that in the chapel of of Jacques Cœur at Bourges. That rich banker, Treasurer of France, who financially befriended Charles VII., left behind him not only a sumptuous residence in that city, but also this surprising window, where splendid costumes vie with the glittering star-spangled ceiling of the most elaborate Gothic dome ever attempted in glass painting. The way in which the picture disregards the mullions and sweeps across the whole embrasure forecasts a common practice in the sixteenth century.

(60) It is well that we have crossed the Channel because, having now reached the sixteenth century, the fewness of its examples in England, even including the magnificent and, perhaps, unsurpassed interior of King's College Chapel, Cambridge, are as nothing compared with the wealth of windows then everywhere blossoming in France. We shall now find larger scenes, more use of perspective, greater diversity of colouring, enamelling of paint upon the surface, carelessness in allowing leads to stray about instead of confining them to outlines, and classic instead of Gothic canopies and architecture generally. A window at Troyes, of the Tree of Jesse type, shows that although the pictures are now painted in a bolder spirit, the old curving tracery lights, long since Perpendicularised in England, still persist in France. In France the descendants of Jesse almost always appear as blossoms on the vine, but their earlier English prototypes usually stand within small cartouches formed by its convolutions.

(61) The gorgeous southerly rosace in Sens Cathedral, depicting the Last Judgment, shows how skilfully the Renaissance glaziers could accommodate themselves to any sort of embrasure. This and the northern rosace were done by three great glass artists, brought hither for that purpose from Troyes in 1500. The French *peintre-verrière* was always more independent of the architect than his colleague in England, where the narrow, almost spindling lancets provided during the Early English period as clearly modified the glazier's cartoons, as in the Perpendicular period did the stiffly upright panels below and the equally upright pill-boxes above in the tracery lights.

(62) It would not be respectful to the city in which your distinguished Society has led so long and so useful a life did I close with no reference to certain really fine examples of sixteenth-century glazing to be seen here in St. Margaret's, Westminster, and St. George's, Hanover Square. In view of the number of weddings that take place at St. George's, it is, perhaps, appropriate that the old glass across the chancel should be a Tree of Jesse.

(63) This Flemish glass, originally made for a church in Mechlin, Belgium, has been tastefully readjusted to its new home in the three eastern embrasures, but that it was originally a Tree of Jesse and all one window is quite clear.

(64) The labels and the portions of the vine alone would prove that fact. I know of no Jesse anywhere possessing such large figures, for they are even larger than at St. Etienne in Beauvais, where, oddly enough, appear contemporary portraits such as Francis I. and Henry II. instead of Biblical worthies. So in the Wine Press window in the Sacristy of Saint Etienne du Mont, Paris, one can recognise the features of Pope Paul II., Charles V., Francis I., and Henry VIII. At Vincennes Jean Cousin placed Diane de Poitiers among the Holy

Martyrs on one of his gorgeous windows. Henry II., who appears near-by as a Knight of St. Michael, must have had small sense of humour to have countenanced such a disposition of his friend!

(65) The East window of St. Margaret's, Westminster, is not only beautiful, but also it has probably suffered more vicissitudes of travel and ownership than any window in the world. On the right side is St. George, and below him the only authentic portrait we have of Arthur, Prince of Wales, while across from him, in the lower left-hand corner, kneels Katherine of Aragon, Prince Arthur's *fiancée*, and, after his death, first wife of his brother, Henry VIII. Above her head is her badge, the pomegranate. It was because of this reminder of his wife's former betrothal to his brother that Henry VIII. started this window on its travels.

(66) It was ordered in Dordrecht, Holland, in 1499, by Ferdinand the Catholic and Queen Isabella, as a gift to Henry VII. to commemorate their daughter's marriage to his son, Prince Arthur, and was destined for the Henry VII. Chapel at Westminster Abbey. It took five years to make, and meantime Prince Arthur died in 1502. His brother, Henry VIII., did not place it in the Westminster Abbey Chapel, but gave it to the Abbey of Waltham. Upon the dissolution of religious houses in 1540, the Abbot transferred it to his private chapel at New Hall, Essex, which, strangely enough, later passed to Sir Thomas Boleyn, father of Queen Katherine's successful rival. Upon his death Henry VIII. seized New Hall on behalf of Anne Boleyn's daughter, Elizabeth. Later, Queen Elizabeth gave New Hall to the Earl of Essex, who sold it to the Duke of Buckingham, and his son sold it to General Monk, who preserved the glass in chests safe from the iconoclastic zeal of the Puritans. John Olmius, New Hall's next owner, sold it for fifty guineas to John Conyers of Copt Hall, who resold it in 1759 to St. Margaret's for £420.

(67) A number of Dutch glass painters, the Crabeth Brothers, Von Linge, and others, worked in England towards the close of the sixteenth century and even a little later, and one of the best specimens of that school's handicraft is to be seen in Wadham College Chapel, Oxford. It is placed in older embrasures, as the Perpendicular mullions reveal.

(68) By this late date glaziers had come to indulge too frequently in painting their pictures on the glass surface and then firing them, giving a sort of enamelled result. This was vastly easier than the laborious leading-in of numerous bits of coloured glass to make up the picture.

(69) This enamelling of glass has, however, two serious drawbacks. One was that where shadows were required, the glass was so obscured by paint as to lose its translucence, and the other was that, in the course of time, bits of this enamelled paint peeled off.

(70) This is unfortunately noticeable, not only in the Wadham windows, but even more so in one at the north-eastern corner of the nave in Christ Church Chapel, Oxford. These later paint-obscured panes make us sigh for the rich pot-metal glass of the early men, who, when they needed dark tones, laboriously leaded in bits of deeply-coloured glass, which gave the required hue without obstructing the light.

So ends our little journey up and down England and France, and now for a few parting words. It would be a fine thing for the cult of ancient glass if such a company as are here assembled could be persuaded to see for themselves the treasures of mediæval colour still preserved after so many centuries for the delectation of us moderns. My poor pictures give no idea of how the originals can and will delight you. They themselves must be seen to acquaint you with their real glories in "the bugle cry of red, the limpid confidence of white, the repeated hallelujah of yellow, the virginal glory of blue-all, the quivering crucible of glass" (Huneker's translation from Huysman).

If you will permit what may seem a digression from the purely artistic standpoint of considering stained glass, it seems to me that the subject opens a window into the field of metaphysics, something which is now receiving more of the attention it deserves than formerly. Stained glass is not only a decoration for a window, not only an artistic addition to architecture, but it is a manifestation of matter being penetrated by something *not* material. It not only illumines, brightens, and decorates interiors of buildings, but it has other metaphysical properties as yet but little understood. We know from experiments conducted at the Sorbonne, Paris, not long before the outbreak of the war, that glass of certain colours distinctly encouraged the growth of certain vegetables. Why? That remains yet to be determined. In Aubrey's "Anecdotes and Traditions" we read: "The curious oriental reds, yellows, blews, and greens in glasse-painting, especially when the sun shines doe much refresh

the spirits. After this manner did Doctor R. revive the spirits of a poor distracted gentleman, for whereas his former physitian shutt up his windows and kept him in utter darknesse, he did open his window lids and let in the light, and filled his windows with glasses of curious tinctures, which the distempered person would always be looking on, and it did conduce to the quieting of his disturbed spirits."

Here is something which one may dismiss with the slighting observation that it is quaint, or recognise as pointing to a *terra incognita*, as yet not "dreamed of in our philosophy." In that amazing book, "The Education of Henry Adams," the autobiographer, himself a learned lover of ancient glass, insists that the entire history of the world should be divided into but two epochs—firstly, that before the discovery about 1893 of the X-ray and of radio-activity (which period he styles the Sensual Epoch); and, secondly, the Super-Sensual Epoch, which, after those great discoveries, turns all our scientific investigation towards the Fourth Dimension, out beyond the limitations of the five senses. Stained glass, considered from this super-sensual angle, affords a fascinating outlook into the Fourth Dimension, and at its very threshold reminds the sightseer that to become something more—to become a seer—he must admit that things material are, like our windows, shot through and beautified by something beyond the material, and therefore subject to higher laws.

I have recently been in Japan, and there, last autumn, in the crysanthemum show at Hibiya Park, Tokyo, I saw more than one example of a great plant burdened with scores of blossoms which, although of contrasting colours, all sprang from the same root. This surprising result was, of course, obtained by an elaborate system of grafting stems from different plants on to a central one. This particularly interested me because I myself am such a product, for although of old Devonshire stock, I am also half Dutch through my mother's family. Just as it was both interesting and instructive in Tokyo to yield to the many-coloured lure of the great chrysanthemum plant, and trace back from the brilliant blossoms to their junction with the parent plant, so I conceive it widely profitable for all of us Anglo-Saxons to permit—nay, to encourage—the gaily-hued charm of your old windows to lead us back to the study of the days before our ancestors branched out from our common homeland in the British Isles.

DISCUSSION.

MR. MORRIS DRAKE said he did not think there was anything to be said about the paper, except to express gratitude for the very straightforward description of the developments of glass and for the extraordinarily interesting pictures illustrating that development. The pictures showed exceptionally fine examples. The only example he should like to have seen added was "La Belle Verrière," at Chartres. But with that one exception the lecturer had managed to capture pictures of every important window in the west of Europe. He had been much interested in the paper and had enjoyed it immensely. As one went through the story of stained glass one always came to the middle of the fourteenth century. Prior to that period there was the French stained glass, and after that period the English. With the one exception from Canterbury he thought the first half of the pictures shown that evening were entirely French, and after that, with the exception of one or two examples, the pictures showed a steady development in purely English windows. It was rather a queer thing to reflect on that turn-over in the middle of the fourteenth century, and he might point out a very curious parallel at the present moment. About the year 1350 there was almost exactly a counterpart of the social conditions that existed to-day. At that time the country was fresh from wars in France, the pestilence was raging (to-day influenza), labour troubles were abundant, and legislation was trying to keep labour in its place. To anyone who had been engaged in the recent disturbances on the Continent nothing was more remarkable than the fact that during two periods of the war the reports of the daily movements of the army might have been taken out of the pages of Froissart. For the ordinary every-day Englishman to see men in steel caps and leather jerkins on the banks of the Somme was opening the pages of Froissart again. Following the period he had just mentioned there was a perfect fever of building, from the middle of the fourteenth century to the end of the fifteenth. Dating from that period there was a type of tower common in Devonshire, which was known all over the world, and in the adjoining county of Somerset a window so well known as to be called a Somersetshire window. He thought there would be an outburst of building now following on the recent disturbances, and there would be a re-birth of architecture such as took place then. All craftsmen engaged in architecture and the allied arts should immediately set their houses in order. The glass painters had recently done their best to set their own house in order by forming the Society of Master Glass Painters, and he hoped they would be able to gain recognition from the Royal Society of Arts and some aid in attaining their aims, which were to encourage a knowledge of stained glass and an increase of skill in its practice, and preserve and keep in the country our heritage of ancient glass. English glass was irreplaceable,

and it was going out of the country in a very large amount. There was a window at South Kensington at the present moment, three panels of fine very early thirteenth or perhaps twelfth century work. The fourth panel was in a collection in Norfolk, and that panel was in great danger of going to America. He was very glad to see the author come to England and study English examples, but he did not see why he should have them to study in the Metropolitan Museum at New York. If the new Society could do anything to keep the glass in this country and induce people to come here and look at it it, would serve a double purpose, and if the Royal Society of Arts could help in that direction the new Society would be exceedingly grateful.

Professor J. M. Thomson, F.R.S., did not feel he was at all in a position to say anything upon the subject except to thank the lecturer for the extremely interesting paper he had given and the compact historical way in which the matter had been presented. He would not venture to soar into the metaphysical question of the effect of coloured glass upon human beings mentioned towards the close of the paper, but he knew that coloured glass had a distinct physiological effect. In conducting photographic classes at King's College, where the developing room was lit by large windows of ruby glass, the red light exercised in many cases an effect on the pneumogastric nerves of the students. At the commencement of the Term some of them had to leave the room on account of a feeling of sickness. After some time they became accustomed to the light, and the feeling of nausea passed off. As a Member of Council he sincerely thanked the lecturer for the extremely able and interesting paper he had given.

Mr. Reginald Hallward wished to add his thanks to the lecturer for the very remarkable series of reproductions he had shown. He should have been glad, however, if a little more could have been said with regard to the particulars of the method of production, because after all that lay at the root of the question of their beauty. If it were possible to have said something as to the way craftsmen in the earlier periods worked, how far the work was personal to themselves, and how far it was carried out by firms with a large number of glaziers, it would be of value. It might be within the knowledge of many that there was in existence the original contract for the famous east window at York Minster, and the Chapter of that day showed a perception of what should govern the production of good work. They made it a condition in the contract that the artist should carry out the work himself. He was to receive twenty-five pieces of silver extra if he did it in a certain time, the time given to him being very ample. No one wished literally to interpret that an artist should do his own work and should have no help at all, because that might be impossible with a glass window which might be perhaps 70 feet high; but the temper and spirit in which the work was done absolutely governed the work when it was completed. When he heard that the Guild of Master Craftsmen in Glass was being formed he attended a meeting, and quite anticipated that he should hear, as in the old Guilds, some consideration given as to the terms in which glass painters carried out their work. He should not expect them to be limited companies or that the genius of one man should be worked through glaziers and painters. He was not offering an expression of view that work was not done now as honourably and sincerely as he should expect his own work to be admitted to be done; he only asked those who cared for the prospects of stained glass to consider the whole matter. It had been said that the object of the new Society was to improve the quality of glass. It seemed to him it was necessary to adopt methods by which better results could be produced. Unless some limitations of employment and some understanding existed that the work of the Guild was subject to some approval, or that a member must pass out of the Guild if he merely became an employer and not a producer, some such conditions as operated in the Guilds of mediæval times, the Guild would become a complete farce on that side of its work, although on the side of the question of the protection of glass in this country he had no doubt it would do very useful work. As an old worker in glass whose work had some reputation in the country he saw no hope of any progress except by the worker himself retaining his own independence and producing work by his own hand with only such little assistance as was absolutely essential to the doing of it.

Mr. Noel Heaton said the paper had awakened many happy memories of the originals, and also had revived a very great regret, because it so happened that in the summer of 1914 Mr. Drake and he decided to take a trip together to study the old French glass, but that trip was stopped by the war. They drew up an itinerary, and came to the conclusion that they could not get through the tour in the one year. In their itinerary they were very largely guided by the author's excellent book, "Stained Glass Tours in France." The very finest example of glass in the French cathedrals was that at Chartres, and in their first tour they made Chartres their starting-place, and finished up at Troyes, and on the journey took some 400 photographs of glass. They came back with the firm intention of going over the following year and finishing the job, starting from Amiens, and, as a matter of fact, they both of them did go to France in 1915, but on a very different errand. He had never seen the results obtained from the first portion of the tour until he saw some of the slides shown that afternoon. If they had gone to Amiens and Rheims and Soissons first they would have obtained valuable photographs of the glass that had been destroyed. He himself was more particularly interested in the technical side of stained glass. The lecturer had shown one or two

examples of the extraordinary vandalism that occurred in the old days, and that was not altogether a thing of the past. He remembered at York being told that there was a certain church in that city which had a very fine fifteenth century window, and the churchwarden decided that it was out of date. Someone who was interested in stained glass asked that when it was taken out it should be given to him. The window was taken out, smashed up, and handed over in fragments under the impression that he wanted the lead. Fortunately that sort of thing was passing away, thanks to the activities of men like General Sherrill, who were impressing on the public the great beauty and value of stained glass. He was sorry that the appreciation of such glass was very much keener elsewhere than in England, because, if care was not taken, there would be very few examples left in this country. Twenty years ago people would not look at thirteenth century stained glass, whereas now collectors would give almost any price for it. He thought very few people ever saw a stained glass window in the proper sense of the word. Anyone who wanted to know what stained glass was had to view it in a very leisurely fashion and spend time on its study. For seeing the "Five Sisters" at York one must sit just within the door at sunset in order to see how beautiful the picture was; as the building became dark, the window lit up, and throbbed and glowed in a wonderful sort of way.

The Chairman, in proposing a vote of thanks to the author, said the thanks of the meeting had been accorded so thoroughly and eloquently by very nearly every one of the preceding speakers, that it was hardly necessary for him to enlarge on the theme beyond saying that the Society was more than grateful to General Sherrill for coming and placing his wonderful life-long and most accurate knowledge at the disposal of the meeting. He was happy to think that General Sherrill had in the records he had shown some permanent memorial of such delicate and fragile work.

The motion was carried unanimously.

General Sherrill briefly responded, and the meeting then terminated.

TRAINING OF HYDRO-ELECTRIC ENGINEERS.

In March, 1919, Professor A. H. Gibson read before the Society a paper* in which he pointed out the necessity for developing water powers within the British Empire, and, as a corollary to this, the need for providing in this country opportunities of training for Hydro-Electric Engineers. While definite courses are conducted in such institutions, for example, as Cornell and McGill Universities, and in many of the Continental technical institutions, very little is done in the British universities and colleges, compared with, say, the courses of instruction in the study of steam engineering. As a consequence of this, the design and manufacture of hydro-electric machinery have generally been entrusted to Continental firms, and of the few really large hydro-electric installations, for which British establishments have been responsible, the greater part of the hydraulic machinery has been made abroad.

In these circumstances it is interesting to learn that Sir W. G. Armstrong, Whitworth and Co., Ltd., have now taken up the manufacture of water turbines, and have established a Hydro-Electric Section of their Civil Engineering and Contracting Department. They are, therefore, in a position not only to deliver water turbine units, but to undertake the hydro-electric plant construction. One of their chief difficulties, however, is that which was adumbrated by Professor Gibson, viz., the difficulty of obtaining British-born hydro-electric engineers.

It would appear that this new departure presents a very favourable opportunity to the many who have taken up the study of water power in recent years, as a result of the greatly increased interest in the subject, to turn their acquired knowledge to good purpose, and to increase it further. Fellows of the Society may know of Engineers who may be looking for such opportunities in the Hydro-Electric world, and a very useful purpose would be served if they would bring this matter to the notice of such individuals.

THE BRITISH INSTITUTE OF INDUSTRIAL ART.

The first exhibition of the British Institute of Industrial Art was opened at 217, Knightsbridge on May 31st. The fact that the Institute, with Sir Hubert Llewellyn Smith as its chairman, has been established by the Board of Trade and the Board of Education, with a view to combining for the first time the educational and the productive sides of industry, leads one to hope that it will efficiently deal with the vital problem of how to bridge the gap that despite all previous efforts still exists between the artist and the manufacturer.

That art can enter industry as an aid to production, ensuring that excellence of design and workmanship which will best lead to *quality* production, hardly requires demonstration. And equally obvious is the corollary, that quality production, by which labour and raw material are used to the best possible purpose, ensures successful competition on the world's markets; a vital matter for our country at all times, and especially at the present juncture.

An effort has been made to demonstrate in this first exhibition that the co-operation of artist and manufacturer already exists, and can be extended. Attractive furniture (not of the "arty" type, but

* "British Engineering and Water-Power Development (The Training of Engineers)," *Journal*, Vol. LXVII., pp. 255-9.

serviceable and simple enough); a wide range of textiles (from the sumptuous three-pile velvets invented by Sir Frank Warner and Macclesfield's best silks, to the hand-woven wools from Ditchling or the printed cretonnes from London and the North); decorative panels (by Rowley and others made of quite ordinary woods, but wrought with uncommon skill); Armitage's carved and gilded frames (only comparable in their gilding to that by such masters in another craft as Grally Hewitt); Hall Thorpe's attractive hand-coloured prints, gorgeous Morris tapestries, one of which represents "The Arming of King George," after Bernard Partridge, all come to show how "things of beauty" may vary in material as well as in style, and be available, not for the lucky few only, but for all.

The first gallery of the exhibition is devoted to exhibits by individual craftsmen, where works may be purchased and carried away. In the Trade section one sees porcelain, pottery and earthenware. Doulton of Lambeth and Doulton of Burslem show their finest works side by side. Mr. Bernard Moore shows us his rouge flambe and other unique pieces, and near by we see the pure porcelain of Minton: Pilkington shows new and interesting tiles, in addition to larger works by Forsyth and others. Messrs. Josiah Wedgwood contribute four distinct types of work, all splendid examples of the potter's craft. The simple ware manufactured with skill and taste by Carter of Poole, and the work of numerous exhibitors from Stoke introduce to the public ceramics of good design, colour and workmanship within the reach of all.

In the Textile section, Messrs. Warner and Son, Messrs. Robersons, Messrs. Morton, Messrs. Tomkinson and Adam, and Messrs. Harrods exhibit large and entirely different exhibits, and in another gallery cretonnes and printed goods of varying kinds make a gay display. The chief exhibitors in the latter section are Messrs. Ferguson, Messrs. Turnbull and Stockdale, Mr. Foxton, Messrs. Stonards, The Ramsden Wood Print Works and Messrs. Story. The Design and Industries Association also have a collective group of interesting work.

The problem of beauty in all objects of the home is proved thereby not to be one of cost. Nor is it one of handicraft *versus* machine production; indeed, in many cases we find that unless the desired works be produced by machinery and in quantities, the prices will remain so high that for all practical purposes the problem remains unsolved. Here, again, it is the duty of the designer to bear in mind the conditions of machine production, to conform to them, and to avail himself of their possibilities to the utmost. There is not a large display of cabinet work, but space has already been requested for the next exhibition by intending exhibitors who through business pressure are unable to be represented this spring. Beside the sumptuous productions of Messrs. Higgs and Hill, designed by Charles Spooner, and the unique work by the late Gimson, and Waals, his successor, it is interesting to see the more simple work by such men as Palmer Jones.

While in the galleries, it was pleasant to hear an authority state "that a new organism had sprung to life and started its task with purposeful earnestness." In addition to the Exhibition an Information Bureau has been opened, which supplies practical data of all kinds to artists, to manufacturers, to buyers and to students. Travelling exhibitions and various forms of propaganda at home and abroad stand next on the programme, and will, it is hoped, considerably extend the range of the Institute's usefulness. Since the opening of the Exhibition the Institute has been approached by two leading bodies in the country with a view to future co-operation, which would seem to indicate that the efforts of the Institute are being favourably received. The galleries will remain open on Tuesday and Thursday evenings and on Sunday afternoons, and it is hoped that it will become increasingly popular through the support of all lovers of art as applied to industry.

[It is hoped that all readers of the *Journal* will support this much looked forward to Exhibition scheme now that it has thrown open its doors. It will be remembered that the question was first publicly discussed at the Society's Rooms in October, 1918. As the *Times* pointed out in its columns on 28th May last, "the problem before the Institute goes to the roots of civilisation," and Fellows are particularly requested to interest the nation in the objects set out in the above article, and thereby link up more closely than ever the aims of the Institute with those of our own, which after all are one and the same.—ED.]

MANUFACTURE OF COCONUT FIBRE IN TRINIDAD.

There are three factories in Trinidad producing coconut fibre. The process of production, according to a report by the United States Consul in Trinidad, is as follows:—

The husks are first battened down in concrete tanks and soaked in water for about five days, after which they are passed through a crusher composed of a pair of cogged rollers pressed together by heavy springs. The cleaning mill consists of a rotating drum about thirty inches in diameter, fitted on the periphery with steel spikes. In front of this drum there is a pair of small feed rollers, through which the husk is fed and held against the rotating teeth. The husk is passed through these rollers as far as possible without letting go of it. It is then drawn back and turned end for end. After that it is turned over and the operation is repeated. The long-staple fibre, generally known as the brush fibre, remains in the operator's hands, and the short-staple fibre, known as mattress fibre, is drawn into the machine. So far as the long-staple fibre is concerned, it is now finished except for drying.

The mattress fibre, containing all the refuse, is

taken from under the cleaning mills and put in the willowing machine, which is an inclined revolving drum covered with half-inch wire mesh, and containing revolving beater drums mounted on a shaft which rotates in the opposite direction to the drum. The fibre is then spread out in the sun to dry, which in fair weather can be done in a day. Finally, it is hydraulically pressed in bales, measuring 20 by 20 by 40 inches, and weighing about 180 lb.

The commercial prospects of coconut fibre are not promising, owing to the increased cost of manufacture and the rapid fall in prices obtainable. The increased cost of manufacture is due to the high cost of fuel oil and the excessive freight rates. It is stated that the cost of freight amounts to one-third of the gross value of the fibre shipped. On the basis of the information available, the production of coconut fibre in Trinidad is not regarded, under present conditions, as a very profitable undertaking.

PRODUCTION OF CANDELILLA WAX IN MONTEREY.

There are great quantities of Candelilla shrub in the Monterey district. It is found chiefly in the Montemorelos and Galeana districts, in the north-eastern part of the State of Nuevo Leon, also in the Bustamante and Villaldama districts, in the northern part of the State. This shrub is grown entirely without cultivation. The average shrub is about 25 inches high; some plants, however, are about 40 inches in height.

While there are, says the United States Vice-Consul at Monterey, several factories making candelilla wax in that district, there was only one large one in operation last year (with a daily output of about 662 lb. of wax) due to the low price of the product in the United States. Another large factory in Monterey is reported to be in contemplation.

After the shrub is pulled out of the earth it is placed in wooden tanks of water which is heated to the boiling-point. At the moment of boiling a certain proportion of sulphuric acid is put in the tanks. As soon as the acid comes in contact with the wax it comes to the surface and is collected and put in receptacles until it congeals; it is then put in another tank where steam is used to dissolve the wax, adding sulphuric acid a second time. The wax is then in a refined state and is allowed to harden in certain moulds. It is then ready for shipment. The wax can also be extracted by direct fire.

THE COMMERCIAL SITUATION IN ITALIAN LIBYA.

Italian Libya now comprises the two Provinces of Tripolitana and Cyrenaica, and lies along the north coast of Africa, between Tunis and Egypt. The extreme northerly point of Libya is at about 33° north latitude; the southernmost point is unknown, as the territory runs south into the unmapped Sahara indefinitely.

All of Italian Libya was taken from the Turks and Arabs in 1911. The whole interior and a considerable stretch of coast-line was recaptured by Arabs, Turks, and Germans during the war. But on April 24th, 1919, a final armistice was signed by the Arab chiefs, who had continued tenaciously to carry on hostilities long after Turkish and German aid had been withdrawn. By the terms of this armistice Italy gained full possession of Libya, as described above.

Only an estimate may be made of the population of Libya. A guess would place it at about six millions, of which perhaps 30 per cent. are Arab, 40 per cent. Negro, 20 per cent. Jewish, and rather less than 10 per cent. European, comprising Italians, Greeks, and Maltese. The Berbers—the original inhabitants of the country before the great Arab invasion of the eighth century—are so intermixed and merged with Arabs, Negroes, and Jews, that they can rarely be distinguished. The Arabs proper—Bedouins along the coast, Tuaregs and savage tribes inland—dominate absolutely.

Commerce is almost entirely in the hands of the Italians at present, though Maltese and Jews act generally as their agents in trade with the natives. The commercial language and currency are Italian English, however, may be used in correspondence, though Italian is naturally to be preferred.

According to data submitted by the office of the United States Commercial Attaché at Rome, since 1887 there has been a serious decline in the volume of trade of the country, due largely to the deflection of the caravans from the interior from Tripoli, their old gateway. Tripoli, 1,200 kilometres due north of Lake Tchad, has always been the natural Mecca for the caravan trade. The route is comparatively easy; at no point is water more than three days from well to well. Although the tribes of the desert have always been comparatively friendly in this region, it must be remembered that the Bedouin is by inheritance and training a brigand. Before any real security of passage may be assured, a competent and adequate military force must be posted all the way from Tripoli to Tchad. In the past caravans of 500 camels and 200 men have been attacked, despoiled, and dispersed; and since the Italian occupation in 1911 these depredations have increased, until now practically no caravan trade remains. In Cyrenaica a few small caravans still arrive. In Tripolitana the arrival of a single unimportant caravan of twenty camels in June last was considered remarkable.

Outside of the caravan trade the chief exports of Libya are sponges, woollen cloth, henna, hides (chiefly of sheep and goat), and esparto grass, which is used in the manufacture of fine paper. All these articles are still exported in some quantity.

During the war the three most valuable products of Cyrenaica—viz., barley, esparto grass, and sponges—were entirely neglected; in 1917 the

exports of woollen cloth and goat skins were the only ones of real importance.

Other valuable products of Libya in the pre-war period were sheep, goats, camels, oxen, horses, skins, Sudanese leather cushions, wool, ivory, salt, cereals, ostrich feathers, butter, and dyewood. There is no doubt that the exports of sponges, esparto grass, barley, hides, wool, and live sheep and cattle may again assume considerable proportions.

To sum up the present commercial situation in Libya, a comparison of the import and export figures of the best year and the worst year during the period of Italian occupation is given, the official statistics for Tripolitana and Cyrenaica being combined: Imports in 1913 were valued at £1,349,000, and in 1917 at £2,332,000. Exports amounted to £188,000 in 1913, and £201,500 in 1917. In the latter year Libya was, therefore, in the unenviable position of having to import goods to almost twelve times the value of its exports.

The future development of Tripoli and Bengazi as principal cities—and of Derna, Tobruch, Misurata, Zavia, and Zuara as minor ports—remains dubious. The development of the great interior, one enormous stretch of Sahara Desert, appears impossible. Railways exist only along the coast, and those for but a few kilometres east and west from Tripoli and Bengazi. Roads there are practically none. To construct railways or build roads across the desert is also impracticable, as the sand shifts rapidly before the driving desert winds, and sandhills 200 feet high will move a quarter of a mile in a few hours. One railway has been constructed for a length of thirty kilometres due south from Tripoli to Suani Ben Adhem, but the trains run irregularly on account of the difficulty of keeping the line clear.

Only in the oases is agriculture possible, and any system of irrigation seems not feasible on account of the absolute flatness of terrain and the lack of watersheds or natural reservoirs of any sort. Water is to be found in the desert at 50 to 300 metres below the ground level, but desert wells can distribute their water over only a few score square metres of land.

The restoration of the caravan trade would do much to rehabilitate the commerce of Libya.

CORRESPONDENCE.

CARBORUNDUM.

I beg to draw your attention to a paragraph appearing on page 459 of the *Journal*, of May 28th, headed "Carborundum." The information contained bristles with inaccuracies, seeing that confusion has been made between the nature and properties of Carborundum and Corundum, which are two entirely different substances.

Reference is made to a Corundum plant at Niagara, it being obvious that the word Carborundum should have been used in this instance. To make it clear, I would point out that Carborundum has substantially a chemical formula CSi, being a Carbide of Silicon, whereas Corundum is substantially pure fused Alumina (Aluminium Oxide), having the formula Al_2O_3. Corundum is not, as stated, in any sense of the word related to the diamond, nor is it necessary for the preparation of synthetic gems such as sapphire, ruby, etc., that great pressure should be exerted, it being only necessary to provide sufficient heat to melt the alumina completely.

W. L. TURNER.

[After the paragraph had been put into type the blunders it contains were noticed, and instructions were given to the printer to distribute the type. Unfortunately these instructions were not carried out, and the paragraph was used to fill up a vacant space at the last moment before going to press, the printer assuming that it had been passed for press, which it certainly had not been.—ED.]

GENERAL NOTES.

DUTCH ROADS AND TRANSPORT EXHIBITION.—A Roads and Transport Exhibition will be held from 15th to 26th September, 1920, at Scheveningen, The Hague, in connection with the first Dutch Roads Congress. It has the support of the Netherlands Government, the organising Committee including Ministers of the Crown and leading Burgomasters, in addition to the chief technical experts. The development of road transport in Holland during the war years was very great, and from being a more or less negligible factor, it has now become a subject of considerable importance. Exhibits are to range from motor lorries and stone-crushers, tar sprayers and concrete mixers, to tyres and signposts, fuel and road-making material, and will also include such smaller accessories as maps and motor clothing. The industries concerned in this list are hardly represented at all in Holland itself. There are no lorry manufacturers, and only two makers of motor tyres. These facts illustrate the value of the opportunity open to British manufacturers of developing an entirely new market.

PROPOSED PORT FOR BHATKAL.—At the request of the Mysore Durbar steps are being taken to construct a harbour at Bhatkal, to provide a sea outlet for the State of Mysore. According to the Department of Overseas Trade, the formation of this harbour has been suggested for some time, and is one result of the commercial expansion of Mysore, which has been increasing for some years past. Schemes for the construction of the harbour have been submitted, including the provision of breakwaters to provide a safe approach during the period of the South-west Monsoon. Accommodation will be furnished for very large vessels, both in the inner and outer harbours.

MOTOR CARS IN NOVA SCOTIA.—The use of motor vehicles has been steadily increasing throughout the Province of Nova Scotia. During the period from 1st January to 10th September, 1919, licenses were issued for 9,770 motor cars and 177 motor cycles. Separate records are not kept of the issue of licenses to pleasure cars and to trucks, and it is therefore impossible to give the exact number of each of these classes of motor vehicles which may now be in use in the Province. Local dealers report the past season as having been a very satisfactory and successful one and state that the prospects are very favourable for heavy sales next season. One factor, according to the American Consul-General at Halifax, which has militated against a more extended use of motor vehicles has been the condition of the roads and highways in certain portions of the Province. Special attention is now being given to the question of better roads by the Provincial Government, and the sales of motor cars will unquestionably be favourably affected by the extensive work now being done in the way of road construction and maintenance. The popular demand is largely confined to fairly light cars of the less expensive makes. Importations from the United States are comparatively small, the majority of the cars sold being supplied by the Canadian branch factories of American concerns or by Canadian manufacturers. Most of the motor cycles sold here are, however, imported from the United States.

BEET SUGAR AND FRUIT-DRYING INDUSTRIES IN AUSTRALIA.—For the purpose of developing the beet-sugar industry Australia has inspected such factories in America, and intends incorporating the most up-to-date machinery for the treating of sugar beet into an Australian plant. The University of California has been asked to select a quantity of the best beet seed for the production of this sugar beet. The Victorian Government has also purchased from America a fruit-drying plant, by the use of which all danger of the Australian fruits being spoiled by rain in the process of drying is to be obviated.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 14 ... Transport, Institute of, at the Institution of Civil Engineer's, Great George-street, S.W., 5.30 p.m. Sir Joseph G. Broodbank, "To-day's Problems in Port Administration."

Victoria Institute, Central Hall, Westminster, S.W., 4.30 p.m. The Very Rev. Dean Inge, "Freedom and Discipline."

Engineers, Society of, at the Geological Society, Burlington House, W., 5.30 p.m. Mr. E. Cressy, "Great Engineering Adventures."

Faraday Society, at the Chemical Society, Burlington House, W., 8 p.m. 1. Messrs. A. Fleck, and T. Wallace, "Conduction of Electricity through Fused Sodium Hydrate." 2. Dr. H. F. Haworth, "The Measurement of Electrolytic Resistance Using Alternating Currents." 3. Mr. J. L. Haughton, "The Measurement of Electrical Conductivity in Metals and Alloys at High Temperatures." 4. Messrs. N. V. S. Knibbs and H. Palfreeman, "The Theory of Electrochemical Chlorate and Perchlorate Formation." 5. Mr. J. B. Firth, "The Sorption of Iodine by Carbon." 6. Mr. F. H. Jeffery, "The Electrolysis of Solutions of Sodium Nitrate using a Copper Anode." 7. Dr. A. M. Williams, "The Pressure Variation of the Equilibrium Constant in Dilute Solution." 8. Miss N. Hosali, "Description of Models Illustrating Crystalline Form and Symmetry."

TUESDAY, JUNE 15...Grotius Society, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Lord Shaw, "The League of Nations."

Anthropological Institute, 50, Great Russell-street, W.C., 8.15 p.m. Professor F. G. Parsons, "Distribution of Hair and Eye Colour in the British Isles."

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. The Secretary, "Report on the Additions to the Society's Menagerie during the month of May, 1920." 2. Professor J. E. Duerden, "Exhibition of, and Remark on, Ostrich Eggs." 3. Miss J. B. Proctor (a) "On a Collection of Tailless Batrachians from East Africa made by Mr. A. Loveridge in the Years 1914-1919"; (b) "On the Type-Specimen of *Rana holsti* Boulenger." 4. Mr. R. I. Pocock, "On the External and Cranial Characters of the European Badger (*Meles*) and the American Badger (*Taxidea*)." 5. Mr. R. J. Tillyard, "The Life History of the Dragonfly."

WEDNESDAY, JUNE 16...University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Professor A. J. Toynbee, "The Middle East—(Lecture III.)—Persian Empire and Hellenism (6th century B.C. to 6th century A.D.)."

Meteorological Society, at the Royal Astronomical Society, Burlington House, Piccadilly, W., 5 p.m. 1. Mr. W. H. Dines, "The Ether Differential Radiometer." 2. Professor S. Chapman and Mr. E. A. Milne, "The Composition, Ionization, and Viscosity of the Atmosphere at great Heights."

Electrical Engineers, Institution of, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 6 p.m. Discussion on (a) the Paper read by Sir Dugald Clerk before the Royal Society of Arts, "Distribution of Heat, Light, and Motive Power by Gas and Electricity"; (b) the "Report on the Coal-gas and Electrical Supply Industries of the United Kingdom to the President of the Institution of Gas Engineers."

THURSDAY, JUNE 17...Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 5 p.m. (Sir Joseph Banks' Centenary Meeting.) 1. The General Secretary, "Banks as a Traveller." 2. Dr. A. B. Rendle, "Banks as a Patron of Science." 3. Mr. J. Britten, "Banks as a Botanist."

Chemical Society, at the Institution of Mechanical Engineers, Storey's-gate, S.W., 8 p.m. Professor J. C. McLennan, "Helium."

University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Mr. M. C. Jame, "Chinese Philosophy."

FRIDAY, JUNE 18... ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4.30 p.m. Sir Valentine Chirol, "The Enduring Power of Hinduism." (Sir George Birdwood Memorial Lecture.)

Sanitary Engineers, Institution of (Summer meeting), Holborn Restaurant, W.C., 11.30 a.m. 1. The President, "The Institution and Its Future." 2. Mr. A. J. Martin, "Sanitary Socialism."
2.30 p.m. 1. Mr. T. Robertson, "Poured Concrete Construction." 2. Mr. G. W. Chilvers, "Health, Wealth, and Housing." 3. Mr. A. P. I. Cotterell, "A Glimpse at Domestic Engineering in some of the Eastern States of America."

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FRIDAY, JUNE 18, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Sixty-sixth Annual General Meeting, for the purpose of receiving the Council's report and the Financial Statement for 1919, and also for the election of Officers and new Fellows, will be held, in accordance with the By-laws, on Wednesday, June 30th, at 4 p.m.

At the Annual General Meeting the Council will propose the following Resolution:—

1. That By-Law No. 56, relating to the annual subscription of members be altered and amended by the substitution of the word *Three* for the word *Two*.

2. That By-Law No. 59, relating to Life Compositions, be altered and amended by the substitution of the word *Thirty* for the word *Twenty*.

The By-Laws, as amended, will then read as follows:—

By-Law 56.—"The Annual Subscription of every member shall be *Three* guineas at least."

By-Law 59.—"Any member may commute or compound for all future payments, and become a member for Life, by payment of a sum of not less than *Thirty* guineas."

(By order of the Council),

GEORGE KENNETH MENZIES,
Secretary.

PROCEEDINGS OF THE SOCIETY.

TWENTIETH ORDINARY MEETING.

WEDNESDAY, MAY 12th; MR. HALSEY RICARDO, F.R.I.B.A., in the chair.

The paper read was—

ROLLS OF HONOUR.*

By GRAILY HEWITT, B.A., LL.B.

When I was asked to read a paper here, the subject suggested to me was War Memorials; and I was at once in a difficulty, for I could not define to myself what a war memorial may or may not be; and if I decided to speak only of such things as without a doubt *are* memorials, I must at once appear too limited or too technical to claim any general interest. The best I could do seemed to me to make some attempt to clear the air about the matter, and then, with apology for narrowness and technicality, to go on to deal with that form of memorial with which my craft, as a scribe, seems to be concerned, hoping you will neither think me presumptuous on the one hand, nor too dreadfully dry on the other.

For apparently many people seem to think, and I do not venture to disagree with them, that anything may be a war memorial, if you intend to make it so—as a public garden, or a bed in a hospital, or a swimming bath, or a scholarship. And indeed one feels that, in the highest sense, our England should be turned into one grand memorial, and that we should best commemorate the sacrifice and glory of our heroic dead if we could realise effectively that splendid dream of William Blake's: "I will not cease from mental strife, nor shall my sword rest in my hand, till we have built Jerusalem, in England's green and pleasant land." And every effort made towards that reconstruction we all have in our mouths, is a step towards this true memorial we desire. Yet we are well aware that, with too many of us, the chief concern is now the practical expostulation against the private injustices five years of war have produced in the adjustments of our daily lives. As if it must necessarily be always some one else's business to bear the

losses inflicted! As if submission (even to an injustice) may not be of the nature of memorial, and unselfishness now the true evidence that the lesson of our loved ones has not been disregarded! As if it were no come-down, after giving sons, brothers, husbands, to exclaim against a petrol tax! We dream we can efficiently record their unselfishness with a clock-tower or a drinking fountain, and proceed to ignore their example with calculations of the ways needed to put our own lives upon a pre-war basis.

The thing we have to commemorate is the glory of unselfishness. The true memorial is a higher standard of unselfishness. So only can we really record what the war amounts to. And unless we admit that, practically and permanently, we are all of us liable to fall, more or less, into the absurdity of that provincial councillor, who was reported in a local paper to have proposed at a parish meeting that a suitable memorial to his fallen fellow parishioners would be the substitution for the uncomfortable pews in his church, of the convenient tip-up seats one finds in the picture palaces. But after all, is his extravagance essentially different from those who design memorial chapels? What is the purpose of a memorial chapel? Shall we have prayers for our dead in it? Shall we even have regular services there, and read out their names lest they be forgotten? Shall we do more than make, at best, a beautiful bit of architecture, open it to visitors, and call it a war memorial? Or a stained-glass window? It is not a memorial without an explanation. Even a stone cross in a village is not a memorial of this war unless it has the identification of the years upon it, without which it remains the general symbol of Christianity. There seems hardly anything we may make, which can of itself be a memorial —without this sort of identification, that is, some reference by inscription. One may except statues, which can but be memorials of one, or a few, or a pillar like Nelson's Column, which is at once and unmistakeably self-explanatory. But who inevitably calls to mind our deliverance in 1815 when passing over Waterloo Bridge? We connect that with the London and South-Western Railway Co. It is next to impossible to imagine any new symbol of the grandeur of self-sacrifice, independent of some inscriptional explanation added to it. Indeed, the dictionary defines a memorial as "Something, as a monument or an inscription designed or adapted to preserve the memory of a person or an event deemed worthy of honour"—leaving one to exercise one's imagination as best one may.

So that while anything may be a worthy memorial if made with true motive, it were a bold man who should come here and speak of methods of construction; or even of the adjustment of suitable inscriptions to such a multitude of objects as may at once be called to mind. I asked, therefore, to be allowed to deal with such inscriptions only, as of themselves compose the entire memorial, that is, the making of records of men's names and deeds, individually or collectively, as by reference to a certain place or a certain regiment; since such records are simply memorials, and not objects of utility or convenience as well—what are called Rolls of Honour. Even so the subject is wide enough, for rolls of honours may be executed in stone or marble, brass or wood, vellum or paper, and may be of any size or shape for that matter.

Their essentials are a "legend" and a list, the legend setting forth of what the list consists, followed by the list. The legend is really most important, and yet it is usually little considered. Committees, formed for the purpose of making local memorials, too often find such difficulty in establishing full and satisfactory lists, that when these are complete no energy is left for consideration of suitable heading; and they content themselves with such words as "Men who fell in the Great War," with possibly the addition of a worn text to be added above or below; when immediately there is introduced a weary sense of stale emotion, the perfunctoriness of a conventional sentimentalism. There are now a dozen or more catchwords connected with these things, to which repetition has brought something like disgust. And one of the few fine phrases the war has given us—Kipling's "Who dies if England lives!"—has been worn to shreds in a newspaper. We seem to lack sense of the elevated use of words. Wisely, the Whitehall Cenotaph said nothing but "the glorious dead." But this very reticence was an acknowledgement of this inability, this literary or inscriptional ineptitude. It has at least avoided the possibility of staleness, it can never become undignified.

The local committee, however, has usually no diffidence in flinging a quotation on to stone or brass. We have all seen "Greater love hath no man than this, that a man lay down his life for his friends." Of the brave boys who are gone, is there one who would be ready to endorse the comparison this implies? Is it quite fair to the dead to overdo and add the tinge of exaggeration's insincerity to our honour? For however true this may be of some of them, there is this general implication of comparison with the typical self-sacrifice which imports that "little more" than truth.

But of most it is not true, and they made no such pretence. They risked their lives, and gave their lives, without any such assumption of altruism. One of our poor words, one of those self-conscious confessions of our verbal deficiency, perhaps expresses it. They did it because it was "the thing," because, as more than one of them has well said, there was nothing else to do. Their enlistment was, in fact, the loyal and ready expression of the social instinct we have achieved. And this has no doubt been fastened on by those others of us who have inscribed Horace's old tag of "Dulce et decorum est pro patria mori," without pausing to consider that the half of this at least is quite untrue. Of the million dead and missing, is there one who found the business of death "dulce"? There is now, moreover, added the suggestion of our society slang, that we consider it "sweet of them."

Besides which, most of us feel that a foreign tongue has no place in records so national. Our own tongue must do. It is strange that Shakespeare gives no help, and that so much that might be quotable from our Bible involves that comparison I have alluded to. Yet there are, of course, many verses applicable; and one of them is St. Paul's phrase "As dying, and behold we live," a curious precedent for the Kipling line I mentioned just now. Of our later writers, here and there may one pick a phrase, and a favourite one is Rupert Brooke's "Now God be thanked who has matched us with His hour." And one most beautiful verse is that of Laurence Binyon:—

They shall not grow old, as we that are left grow old:
Age shall not weary them, nor the years condemn.
At the going down of the sun, and in the morning
We will remember them.

But of all the poetry I have searched for help, there seems to me nothing comparable to those lines of Tennyson, from his ode on the death of the Duke of Wellington:—

A people's voice! we are a people yet.
Tho' all men else their nobler dreams forget,
Confused by brainless mobs and lawless Powers;
Thank Him who isled us here, and roughly set
His Britain in blown seas and storming showers,
We have a voice, with which to pay the debt
Of boundless love and reverence and regret
To those great men who fought, and kept it ours.

On the whole, however, it seems safest to omit such quotations—at least, if the inscription is very public, not in a book—and to confine the legend to a severe and literal statement of fact, leaving the fact to speak to those who can listen to facts, and avoiding all catchphrases such as "Great War," "European War," "World War," "King and Country," and, worst of all, "Supreme sacrifice." I have even met "shed their blood," and that dreadful "did their bit" formally inscribed. There seem so many to whom English, just English, is dry pedantry, to whom nothing makes an emotional appeal unless it appear in guise of slang or the petticoats of sentimentality.

I usually suggest something like this—even if I am not asked: "Of the parish of Blank in the county of Blank These gave their lives serving the King in the years of Our Lord 1914–1919," which seems to me accurate, entirely sufficient and conveying every implication necessary. When the roll is of *all* who served, and not the dead only, I put "served" instead of "gave their lives serving," and then distinguish the dead by gilding their names in the list, or by putting a gold cross before their names. Note that the word "these" conveniently includes both sexes. And I attach much importance to those words "served the King" or "serving the King." Occasionally a republican-minded client has absurdly objected to them, and has asked them to be altered to "served their country," which is a much weaker expression, meaning simply "helped to preserve it from its enemies." Serving the King implies this and much more than this, it implies serving the cause of Truth, Right and Honour. There is a grand traditional significance in the words. And our form of Government being what it is, they are the correct general words for employment in His Majesty's Naval, Military, and now Aerial Forces, and involve no politics whatever. The King is symbol and embodiment, and I confess personally to finding a noble ring in the words I would not go without.

Again, I constantly see the years mentioned as 1914–1919 or 18 or 20 as may be. This seems to me too colloquial for use for our purpose. After all our era is not worldwide; and there is a literal dignity in acknowledging this. So "Year of Grace," "A.D.," or "Year of our Lord" seems necessary. Moreover, by so stating it, we verbally connect the sacrifices recorded with that typical sacrifice, but modestly and indirectly. Here again the client has sometimes to be persuaded. For the heathen-minded is apt to consider he lives in 1920, or "the year 1920," without admitting that neither wording is accurate enough for a thing so formal as a memorial inscription. It is, in fact, an abbreviation. The legend above suggested seems appropriately sufficient in the case of a panel. But if the form of the memorial is that of a Book, the wording of its title, its preface or introduction, may well be considerably more than this. In the case of a school or other old foundation, it seems handsome to introduce at least some of the old school prayers, which the boys have grown up with and learnt to live by (or at least

have learnt to love as part of the dear old place and its ways). And in books much local or explanatory matter may also be introduced. Perhaps even on a panel one might add the words "at home and abroad" (though the words I suggest really include every field). And sometimes the theatres of war may need mention as Gallipoli, Palestine, Mesopotamia, France or Flanders, or indeed particular battles or actions.

And then the names. Is it unfair to say that the Church had a chance here, and has not taken it? In how few of our country parishes did the parson at once set about keeping record of his flock! In how many places is not the memorial even now held up for want of a reliable list! Of course it was difficult; the black sheep, the enemies of church-going were among the first to go, the least missed; and we all know the difficulty of defining the word "parishioner," even in parishes with a fairly stable population. Yet if the Church had done this thing well she might have retained some of that grip upon our lives she complains she has lost and is losing. This was a practical and valuable way of asserting her claim, that not one of these fell to the ground without a father's knowledge. It seems to have been nobody's business in particular.

Such lists as we make are, moreover, nearly always lists of surnames. It would be almost impossible to hope for a list with full Christian names. Outside our families we are all known by initials. Initials do not look well in a roll of honour. They have a dry perfunctory look. Men are baptised by name, not initial, and a roll of honour seems to demand a similar fulness. If, however, we must have initials at least we can put them in front of the names and not after, as is done so often by those who would sacrifice all to alphabetical *appearance*. I say *appearance*, because the alphabetical order is not altered by putting the initials first. Brown, F. L., Jones, G. J., and Robinson, W. M., are impossibly "indexed." And besides the names, in most cases people seem anxious to have the ranks and regiments mentioned to which the men belonged. And one usually falls in with the suggestion, since at once a decorative columnar arrangement can be adopted and an orderly plan formed. Yet one may wonder, perhaps, whether this little piece of the end of a life-history is better worth recording than much that went before. If is of little comparative importance whether a man was a Queen's Westminster or a Post Office Rifle. It might be much to know whether he gave up banking or baking, or linen-draping to lay down his life in Flanders. In one list I have made the names of the men's mothers and fathers were given. And this struck me as fine and just that their relatives should so claim the honour of record in company. Details of place and date of death seem naturally desirable, where known, and mention of actions, and battles, and wounds, and, of course, the initials of distinctions won, as V.C., D.S.O., M.C., D.S.M., M.M., etc. These may well be added in gold immediately after the man's name.

The fulness and amount of detail to be given usually settle whether an arrangement in columns or by paragraphs be preferable. When rank, regiment, name, and date of death are the particulars supplied, the arrangement by column may well be adopted, since an orderliness and decorative appearance is at once provided, especially if one or two of the columns be written in colour, leaving black for the names themselves. If, however, many details besides these are desired with each individual a small paragraph may well be allotted. Or, again, if nothing but the actual names are needed, and these are not numerous, a fine effect may be made with the extreme simplicity of writing them continuously as a single paragraph, and so making a decorative panel of the massed names. In this case the individual name is lost sight of in the general effect—a thing one's first thought rejects and one's second may well approve. A paragraph so designed and rendered entirely in gold lettering on vellum would make a fine panel.

Most usually, when the names are numerous and arranged by columns with rank and regiment, I have found it clarify the work to put them thus:—

Rank.	Name.	Regiment.
Blue.	Black.	Red.

reversing the colours for the Navy. And if this roll is one of service and not of the dead, the names of the living can be rendered in black, and those of the dead in gold. No note of explanation seems to me to be required. By this plan the names are brought down the centre of the page or panel, as may be, and may well be written larger than all else.

But in what order shall the names be set? In most cases an alphabetical order seems preferred, as if any other arrangement made for invidious preferences. Yet, why not? Indeed, before conscription came a roll of service seemed very rightly to be arranged in order of enlistment. Unfortunately this order was too rarely known to be available, and after conscription

it conveys no necessary information. By date of death is another possible arrangement, where the roll is of the dead only.

Or, again, the arrangement may be by reference to regiment. This is, however, awkward except where the list is a very large one, and the names fairly distributed among a number of regiments, or except where, in a parish, the men have all belonged to one or two regiments. And this is rarely the case. In the South African Roll for Capetown Cathedral this arrangement was adopted, the names were marshalled under regimental headings and under subheadings of rank, officers by seniority, non-commissioned officers and men alphabetically; and all regiments and names were treated equally, the order being that of the Army List. But in that case there were 22,000 names and more, and the whole of the British Army, I think, was represented. No other arrangement was possible.

As to the names of regiments, unless these be given in full (which is most inconvenient with the limited space usually available), there is always a difficulty. For most regiments have alternative and supplementary titles, or an official title and a popular one, and there seems to be no principle to go by. Indeed, the King's Librarian has informed me that there is no consistent usage, so that most rolls adopt the popular names, and the scribe must inform himself as to these. For instance, the Queen's Bays do not care to be called the 2nd Dragoon Guards nor the Royal Scots Greys, the 2nd Dragoons, nor the Black Watch the Royal Highlanders. Yet the three latter are all the correct short official titles, and the only names given in the scrolls for the next-of-kin now being issued by the War Office. So also the East Kent Regiment is more popularly known as The Buffs, the Royal West Surrey Regiment as the Queen's, the West Riding Regiment as the Duke of Wellington's, and so on; and one might imagine the horror of a sergeant of the London Scottish at being described as of the 14th County of London Rifles, or of a Queen's Westminster or a Post Office Rifle at 16th County of London or 8th City of London being considered sufficient. With some regiments the War Office is even now making alteration. The Welsh Regiment and the Welsh Fusiliers may now spell their name with a "c"; but the Welsh Guards will retain the "s." The Notts and Derby Regiment are, I believe, about to become officially, as well as popularly, the Sherwood Foresters.

A further point is the abbreviation and contraction of regimental names. We have written in initials during the war, and there was, no doubt, good reason. But on a roll of honour these initials look merely slipshod; and even contractions are only advisable to keep the arrangement fairly uniform. One must contract the Argyll and Sutherland Highlanders somewhat, as also the Oxfordshire and Buckinghamshire Light Infantry. But R.A.M.C., K.R.R.C., K.O.Y.L.I., R.G.A., R.F.A., R.E., and so on, seem on a record too much like slang. Official contractions are given in the Army List, but I am afraid they have not a very literary look.

As to the forms of rolls of honour, these seem to be the panel form (where the names are not too numerous, or space allows of several side by side) and the book form.

Panels may be single, or made up into diptychs or triptychs, or set in frames in a line of several. And they are no doubt usually chosen that all the names may be equally visible on one sight line or thereabouts. A book either shows but one opening, or, if accessible for turning, is liable to dirt and damage. Yet I feel that as a record it is preferable, and, where guarded by a case, will easily outlast all others. Indeed, a parchment book, kept dry and well used, is practically indestructible. There are many of us, too, who do not particularly value seeing the names as in a shop window. We want to know that they are there preserved for all time. That is primarily what such a record is for—not for exhibition. Strolling in Canterbury Cathedral lately I looked at the various military memorials in the nave, containing the lists of names of men killed in former wars. To their own generation they meant somewhat; but to the stranger these monumental panels looked dreary enough. They are not decorative, mostly hideous, with black rims, stupid carved cannons, and presiding goddesses. Are we going to fill our churches with such things by the hundred now?

Is not a book a handsomer thing? Not only can it be made more decorative in itself, but it will not disturb the architecture of the place nor obtrude itself to the offence of anyone. It is ever more interesting than memorials which display all their contents at a glance, with its suggestion of treasure gradually unfolded to the reader, and not worn away by time, or the very care which would preserve stone or brass by the necessary cleaning of them. And, further, a book would offer a delightful opportunity for usage—if ecclesiastical authority could be persuaded to countenance it. On some anniversary, as of Peace

Day, or oftener, in the years to come, the book could be read out from the pulpit to the congregation. It would seem to me that such a reading would be more likely to keep alive the record of the names than will the plastering of walls with lists which will shortly be no more than glanced at, as those in Canterbury were by myself. There is precedent for such usage in what is called the Bidding Prayer, enjoined by the fifty-fifth Canon of the Anglican Church in 1603, and still used occasionally, I believe, in some cathedrals and churches, wherein mention is made of benefactors passed away. Are not these dead heroes our greatest benefactors ?

Or, again, where the names are numerous, as in many large towns and cities, these may be divided by 365 or 12, and so many as result set to an opening or page of the book; and each day or month a page could be turned so that throughout the year the book would display every man's name in turn, and thus become a new sort of calendar of saints. And possibly the names could be ordered by reference to date of death, even yet more appropriately. Indeed, I have made one so. Such books could be kept on lecterns under glass against the wall or a pillar of the church.

Stone or marble lists are only suitable where the names are but few; otherwise these tend to be cut so small, as not to be cut well. A monument with ill-cut letters is at once a failure. And to me *incised* cutting is always preferable. The Imperial Roman inscriptions were always incised, and, indeed, most also of the Renaissance inscriptions, though the raised letter with its stronger effects is established by that time too firmly to be thrown overboard. This was not originally a stone letter but a metal letter (a metal worker's or die-cutter's letter), and was adopted for stone work in a mistaken care for conspicuousness, and then established by lovers of ostentation.

And in incised cutting nothing is so fine, because so well adapted for the tool, that is the chisel, as the Roman capital alphabet, those majestic majuscules evolved by true craftsmanship, and developed by sympathetic refinement —all impertinent experiments in turn eliminated as in other natural processes—through the ages.

But with brass one may be permitted to question their advisability. Brass is not beautiful in itself as fine stone or marble is beautiful. It has no grain or texture, no warmth and variety of colour, no translucency as of marble or alabaster. The beauty must be given by the writing and by the contrast of the colour of this, either the writing or the ground being blackened or coloured. And one always recognises in fine mediæval brasses that this effect was valued—what one calls "fine *colour*." And to get this an alphabet is necessary which shall not have the refined elegancies of the Roman inscriptional majuscule. The best examples, being those of Gothic times, are of course examples of black-letter. And black-letter, as is implied in its very name, was an alphabet of heavy strokes. Hence the ease of the noble effect gained with it. But nowadays one may hardly use black-letter without danger of illegibility in writing letters which do not belong to our modern life and literary conventions.

I venture to suggest that this double difficulty may be overcome by employing the Roman minuscules, with great thickness of stroke and packed very tightly. Used thus they will give great beauty of "colour," almost as effectively as the Gothic letters, and yet remain legible. Moreover, I have found that the graver prefers the rounded forms so provided to the angularity of the chisel-cut shapes, which are properly fitted only for stone work; which is only to say that one needs to consult the particular material one is working upon.

Italics seem to me unsuited for inscription, except, perhaps, on slate, where the difficulty of the material seems to suggest a fine, that is a thin, line. They are too essentially pen-forms, and thin pen-forms at that, not needed for stone, for which the Roman minuscule suffices, where a minuscule is really advisable, and quite out of place on brass, where thick work is wanted, which is contrary to their nature.

Then there are painted letters—that is, brush-made letters. Now, as a penman I have a sort of jealous dislike of painted letters. Letters are not painted things. The brush seems never to have evolved a real alphabet of its own in which its technique might have appropriately modified traditional form to its peculiar requirement. At best it but makes, and always has made, imitations of the more direct appearance of pen strokes, and its proper use would seem to be limited to those places, as walls or roofs and ceilings, where a pen cannot work. But where, as with most rolls of honour, the thing is a panel however big, and not necessarily written *in situ*, and so upright, there seems no occasion for brushwork, except on such surfaces as a pen cannot manage. Justification for using such surfaces would be very exceptional.

A pen can be made of any size for reasonable requirement, of reed or cane for large work.

The so-called "parcel pens" of commercial use give true pen-forms, which seem preferable to the laboured imitation of the brush. A pen certainly will not work with oil colour, but there are waterproof inks which are very serviceable, and only when the panel's surface needs to be an oil-painted surface, to be in keeping with the rest of the memorial, does a real necessity for the brush arise. Otherwise, where vellum is not used, a very good surface for the pen's performance can be made of a gesso well sized. On this the pen will work almost as well as on skin, and the gain to the writing is very marked. With this there is none of the almost inseparable feebleness, the faking and retouching of letters which the brush seems hardly able to avoid. It may be argued that this depends only upon the skill of the painter. But the penman knows it is not so, and that one might as well try to carve wood with a hat-pin or paint with a palette-knife as think to reproduce the derivatives of the Roman alphabet with aught but the tools which evolved them. It might very well have been otherwise. The Far East has brush-made writing, and one can, perhaps, imagine that the brush might have rendered our own alphabet with a developed technique of its own, applied perceptively and, in process of time, magnificently. Only this has not happened. For pen work, then, on a large scale gesso panels may be used, for one has to remember that vellum and parchment skins are not available larger than four feet by three at most. And these are best stretched—after one's work—upon stretchers as for painters' canvases. Vellum—that is, calf skin—is best, of course, but now very expensive. Parchment (that is, the split skin of sheep, lamb, or goat) does very well for smaller work. Until lately I found the unsplit skin of sheep (known in the trade as "grained forel") very useful; but now it is all used up for boots and shoes, I am told.

All skins have a "quality" no gesso, cardboard, or painted surface can approach. There is all the difference between transparent and opaque complexion. It is a constant wonder to me that artists do not make their black-and-white drawings on parchment for the advantage of this "quality." But skin has the further advantage that it has no grain to trip the pen. Moreover, if kept fairly dry, it is practically imperishable. The mediæval parchment books will easily outlast their contemporary architecture. Most modern churches, however, especially now, are apt to be damp at times. In such cases the framed rolls should be well protected by waterproof cloth backing, and the frame, where possible, kept from the wall with little corks at the corners. And, in particular, the glass in front should be kept from the surface of the skin by means of a mount (hidden, if need be, by the rebate of the frame), this mount raising the glass about half an inch from the skin, that cockling may not be encouraged by condensations on the glass, or raised gold used in the decoration of the MS. touched by it.

As to the decoration, I hardly venture to make suggestions. There are so many things I do not want. I do not want flags; flags are meant to wave in the wind, not to be draped and flattened to a design. I do not want cannon, nor khaki-clad figures, nor feminine angels pointing upwards, nor goddesses of Peace pointing downwards, nor Britannias mourning, nor any of the pomps and circumstance of funerals. The recent show of war memorials at the Royal Academy evidenced a great deal too much gloom. These records are lists of heroes. If we have to commemorate the loss of them we have also the gladness and glory to commemorate that Britain has bred so many thousand such; and another rather important thing, here so generally disregarded: that they won the war, that they are not only heroes, but victors. Theoretically I want them all to be written in gold on purple. And since, as a matter of fact, that particular combination is somewhat ineffective, I want at least colour as well as fine letter forms; and all such symbolism as our oak and holly and ivy and rose and hawthorn, and, of course, the bay can import, woven into wreaths and garlands or the very bodies of prominent letters, as in the true illuminator's manner, especially those calendars in the Psalters of old. And of course, wherever possible, heraldry. To accompany lettering there is no decoration so happy and sympathetic. Heraldry *is* almost lettering, the language of signs for words. It is unfortunate, however, that the regimental badges are mostly so poorly designed, and the designs by use now so stereotyped, that their introduction is rather a hindrance than a help. But even without designed or woven decoration we may have the help of colour. For colour not only decorates, but, as a matter of fact, also clarifies the arrangement (as I hope the few examples I have brought sufficiently suggest). And besides colour, gold. It is rather remarkable that, in spite of the centuries' denunciations of riches, we still gild the cross upon St. Paul's, and can separate all sordidness from our admiration for this beauti-

ful thing, and pay our highest honour with it. It is still *the* symbol of value.

Just a word of warning of very practical sort. To those who intend to set a roll of service in a church a "faculty" is needed, at least for anything of the nature of a fixture, and this "faculty" will not be granted if the roll contains the names of those still living. Why this should be so, Heaven knows. It means that our bishops hesitate to create a precedent even in times unprecedented. It has not been done before. Only if you are dead can your name be set in a church, and then you cannot, as a rule, be prayed for. And another still more practical. This craft of formal penmanship, though fostered latterly in our technical schools, largely under the enlightened influence of the London County Council, has not hitherto offered such an outlet as a means of livelihood as to encourage very many to adopt it. There has been no market for it. But now the occasion has come—and a market. But that occasion will not last. When these records are completed the market will probably be done. It therefore seems reasonable to suggest that rather than call for an increase in the number of scribes at once, who will in a year or two be thrown out of work, we were better advised to spread the work over a longer period and establish the few in more lasting occupation. At present there are some forty-odd scribes working upon the memorial scrolls I have mentioned for the War Office. These scrolls will probably be completed this year, and scribes trained and competent will be available for and needing other similar work. Is it too much to ask that committees of memorial records should not be in a hurry to have their works completed? After all, these things are not intended temporarily to aid a passing fashion, but to last. And to be in a hurry over them may not only mean that they may be hustled and ill-done, when we need them done with as much care and practised experience as may be, but also surely implies that we already feel ourselves in danger of forgetting. Are we going to forget these names unless we scrawl them up at once somehow?

DISCUSSION.

THE CHAIRMAN (Mr. Halsey Ricardo, F.R.I.B.A.) said the paper was a very pregnant one, and probably contained some things which were provocative.

Replying to some questions, the author said he knew several churches where there were lists of men who had served in the Army, but probably they were not fixtures, and so it had been possible to avoid the Faculty in that way. He did not know what was the correct way of putting the dates with regard to the war. The War Office at one time gave 1918, the date of the Armistice, as correct, and then January, 1920, as the official date. There was still, however, the Turkish matter going on, and that might complicate things. If it were the case only of the dead, the date of the Roll could be fixed by the date of the death of the last man on it.

MR. W. MORRIS said those who were responsible for advising Committees on erecting memorials were generally hard put to it to find sufficient money adequately to do the work, and that appeared to be the principal trouble in connection with recording the list of men who had served, apart from those who had died. If the 6,000,000, or whatever it was, were all recorded, the cost would be so tremendous that the quality of the work would naturally suffer. A parish that had to report 100 names of men who had died might possibly do something worthy with the money they were able to raise, whereas if they had to increase the names tenfold it would mean very indifferent work for the money at their disposal. Possibly the reason why a Faculty could not be obtained for the names of men who had served being placed in churches was that it was found safer to lay down a rule that only those who had died should be recorded, and also many of those who had served objected to their names being on the list, as they did not want to see them when they went to church. He would like to know whether the author had heard of the new idea that Mr. Wratten had been working on in connection with modern heraldry; he had very cleverly introduced all that could be said in tokens of heraldry—for instance, the badge of the regiment would be the crest so far as it could be applied, the years of service would be shown by chevrons, the rank would be for a captain three stars, and the colours of the regiment would be introduced. The College of Arms, however, had promptly turned the scheme down. The idea appeared to bring heraldry within the reach of commoners, and would cause people to take a very laudable pride in the history of their sons.

MR. W. H. GODFREY said there was no doubt that the essence of a memorial was both the beauty of expression and the method of putting it in the form of lettering. He had been much interested in the reference to heraldry. He had been invited to discuss the subject at the Art Workers' Guild shortly. The matter was put forward in the *Connoisseur* about twelve months ago, and was purely a notion for combining in one emblem the service record of each man, whether he was a member of the Army, Navy, or Air Force. For some time he had been trying to discover how to put the whole military service of one individual in one emblem, and then it occurred to him that the ribbons and badges a man wore were so

essential that, apart altogether from the beauty and importance of heraldry as heraldry, the same principle might be used that the heralds of the thirteenth century used in forming an emblem that would give succinctly the record of a man's service. He did not for a moment wish the idea to be put in competition with heraldry; the word "heraldry" was simply used because of the mechanical method of combining the badges and colours, and had no other heraldic significance. Where there was a particularly beautiful roll required, as, for instance, in the case of a college or private association, where full particulars of a man's service could be obtained, it was possible to make a beautiful symbol.

Mr. C. Harrison Townsend was glad that the author had widened his scope and considered the setting of the inscription, beginning at the very beginning of things. After all a memorial was an inscription, and everyone had some idea of the embellishment and setting of that inscription. A great debt of gratitude was owing to the author for so beautifully emphasising the importance of the inscription in a memorial.

The Chairman, in moving a vote of thanks to the author, thought the thing that had to be considered, besides the making of a memorial, was the retaining of the memorial in one's memory. He had been very much touched by Mr. Hewitt's notion of turning over the various pages of a book once a week or once a month, so that the names should be brought to remembrance. There was a natural tendency at the present moment to make great efforts, both pecuniary and enthusiastic, to raise memorials, and there would be a tendency by-and-by, when the wave of emotion was slacking, to think that we had "done our bit," and were not called upon to do anything more, and it would be a great pity if the memorials were allowed to get shabby or neglected. Something could be done, he thought, in the way of having periodical memorial services of a very simple kind; they need not necessarily be ecclesiastical at all, but such an arrangement as a meeting, say, on August Bank Holiday of the villagers at the memorial, bringing flowers and holding a simple service. It would have the advantage of ensuring that the monument was kept in decent condition and that the lettering was kept clear. It was really important to insist on the maintenance of the memorial after it had been made. With regard to heraldry, it was a kind of shorthand. It began in days when people could not read, and was very effective in showing who was who and how he came about and what his rank was. There was an immense amount of living heraldry to-day, as, for instance, the blazers of schools and football and cricket clubs, the colour of omnibuses, and the colour of pillar-boxes. Within certain bounds it was possible to play with heraldry and use it for definite purposes, and there was no doubt that it was a means of introducing a great deal of interest and colour and history which otherwise would take pages perhaps to explain. No one could have listened to the paper without being extremely interested and illuminated, because problems were dealt with which had hardly come into prominence yet, and to have an authority like Mr. Hewitt dealing with the matter was exceedingly instructive.

The motion having been carried, Mr. Graily Hewitt briefly returned thanks, and the meeting terminated.

THE CLOCK INDUSTRY OF NAGOYA.

In Nagoya are produced about 75 per cent. of the clocks manufactured in Japan, most of the remainder being made in Tokio. The industry grew out of the attempt of a mechanically-gifted native of the near-by town of Okazaki to duplicate a clock brought to Japan some years previously by one of the officials despatched by the Government to the International Exhibition held in Vienna in 1873. In 1886, after a year of constant effort, this man succeeded in making two clocks that could be regulated fairly well and kept good time. In the following year a clock factory was established in Nagoya under the name of the Jiseisha, but it was not until 1890 that its products were put on the market. In 1891 three more factories were opened, and at the present time there are nineteen factories in Nagoya, with 1,200 employees, devoted to the manufacture of various kinds of wall, mantel, and alarm clocks. By 1894 the number of clocks produced was sufficient to supply domestic demands and to permit of the export of a number to Korea and China. The following years witnessed a widespread distribution of Japanese clocks throughout the Orient, and they are now exported to all parts of the world.

According to a report by the United States Consul at Nagoya, it appears that before the war England and Switzerland almost entirely supplied the iron and steel materials from which the clocks were made. After the outbreak of the war, however, when European supplies ceased, limited quantities of wires and springs were received from the United States. This supply subsequently failing, the clock makers were obliged to turn to domestic sources, and by the time the war was half over the Imperial Iron Works at Yawata, Kiushiu, succeeded in making steel springs and wires of fair quality for use in the manufacture of second-grade clocks, which partially supplied the urgent demand. The same firm expected by April this year to be able to make tinplate and springs of good quality, but the clock makers are not sanguine that this expectation will be realised. Upon the cessation of hostilities they endeavoured to place orders with the firms in England and Switzerland with whom they did business before the war, but were disappointed owing to the difficulties experienced by these firms in resuming work, which made it impossible to guarantee definite delivery dates in filling orders.

The outbreak of the war naturally terminated

the export of German clocks to the Far East, and the suspension of this competition brought more orders than could be filled by the Japanese makers, handicapped as they were by the lack of proper materials. This is evidenced by the marked falling off in production during the year ended March 30th, 1917, as compared with the previous year, although at the same time prices rose about 50 per cent. In this connection it is interesting to note that the average price in the year ended March 30th, 1916, was 4*s.* 4*d.*, as compared with 10*s.* 3*d.* in 1919. While the increased cost of labour and materials is in part responsible for the higher prices, they are undoubtedly largely due to reduced competition.

The Nagoya customs figures show that while in May, 1919, almost double the number of clocks were exported to China, as compared with the corresponding month of 1918, in June and July only about 40 per cent. were exported, as compared with the same period of the previous year.

The clocks of different varieties and grades sell at wholesale for from 30 yen (yen = 2*s.* ½*d.* at par) to 100 yen per dozen, the cheaper varieties being sent to China and the South Seas. The dealers anticipate additional good markets for the low-priced clocks in South America and Africa. The higher-grade varieties are now finding a sale in Europe and America.

The following figures were obtained from the Aichi Clock Makers' Guild, showing production and distribution of their products during the four years ended March 30th, 1916–1919 :—

Year ending March 30th.	Domestic use.		Exports.		Total.	
	Number.	Value in U.S. dollars.	Number.	Value in U.S. dollars.	Number.	Value in U.S. dollars.
1916	71,313	110,423	273,278	249,104	344,591	359,527
1917	27,309	45,227	185,901	311,113	213,210	356,340
1918	34,606	73,967	271,183	458,701	251,789	532,668
1919	29,891	83,044	285,645	702,979	315,536	786,023

The destination of the exported clocks during the year ended March 30th, 1919, was as follows ;—

Destination.	Number.	Value.	Destination.	Number.	Value.
		U.S. dollars.			U.S. dollars.
China	183,888	510,046	Peru	421	1,074
Kwantung Province	42,045	100,258	Other South American countries	516	597
Hong-Kong	30,925	47,907	Egypt	1,079	1,488
Straits Settlements	6,932	11,026	South Africa	498	537
British India	2,601	5,707	Vladivostock	181	468
Dutch India	9,778	11,747	Other countries	673	1,104
French India	583	1,332			
Philippine Islands	3,758	7,780			
Great Britain	1,767	1,908	Total	285,645	702,979

MINERAL WEALTH OF FINLAND.

A close study of the mineral wealth of Finland is being made by the Finnish Geological Commission, whose objects are: (1) to examine the extent, value, and utilisation of known mineral sources, and (2) to search for new deposits. Surveys have already been made regarding materials such as calcareous rocks, brick clay, whetstone material, bog ore, rare metals, and to some extent granites. A survey will next be made of iron ore deposits, and estimates of quantity and quality obtained. This will include also research into methods of refinement which will be done in a special laboratory.

According to a report by the United States Diplomatic Commissioner at Helsingfors, the following are the most important of the older iron fields in southern Finland: Pitkaranta, on Lake Ladoga, which contains large quantities of magnetic iron ore, mixed somewhat with sulphides; Kelivaara, an adjacent iron field with similar ore; Valimaki, in the parish of Sordavala, with ore which must be crushed and made white hot before use, but which yields particularly good pig iron: and Jussaro, a large part of which lies under the sea, where the low percentage of metal, in places so far worked, renders it still uncertain whether it can be utilised after the preliminary crushing and separation.

Finland's iron-ore possibilities, however, lie chiefly in Lapland, which is known to be rich in iron, but even here there is no probability of finding rich ores of the kind found at Gellivaara and Kiirunavara on the Swedish side. There are no corresponding geological formations in Finland, and the Swedish formations do not stretch eastward over the frontier, but southward, parallel to it, toward the Gulf of Bothnia. On the other hand, there are on both sides of the frontier fairly extensive areas of another kind of magnetic iron ore. Most of those on the Finnish side, at Juvakaisenmaa and Kolari, have long been known; but it is owing chiefly to the geological researches of Dr. V. Tanner, the Finnish geologist, that those on the Swedish side have been brought to light. It is thought that the deposits at Juvakaisenmaa are sufficiently large and rich in metal to be worth working if transportation facilities were

better. The ore, however, is not of the best grade.

There are also iron deposits on the Finnish side at Kittila in the Porkonen-Pantavaara field. These have long been known. There is no doubt that there are larger quantities of ore, but much of it is of such a kind as to necessitate crushing and heating before use. It is not yet known whether there is ore that can be used directly. The ore seems to be of much the same kind as that in Sydvaranger, on the Norwegian side of the frontier, where work for a considerable time has been carried on rather largely but with varying success.

The copper deposits at Orijarvi and Pitkaranta have long been known; and although their metal content is low they cannot be regarded as exhausted. During recent years considerable deposits of copper pyrites and sulphur ore have been discovered in the so-called "Kalevian" rock strata, which runs from Lake Ladoga towards the Ulea marshes and thence towards the north. The most important of these are the copper deposits at Outokumpu, which in size and metal content deserve to be described as the Finnish Falun. (Falun is the Swedish copper district.)

There are also sulphur-ore deposits at Otravaara in Eno and at Tipasjarvi in Sotkamo, the former having been known for some time without, however, attracting much attention. The war-time increase in the value of sulphur rendered the working of these deposits worth while, and from these and probable new finds it is hoped to obtain not only copper but sulphur far beyond domestic requirements.

Zinc blende has been found here and there although it has not played any economic *rôle*. Lead ore also is known, and may possibly suffice in the future both for Finland's requirements and for export.

In addition to their economic importance, the above-mentioned finds of pyritic ores have an indirect significance. Owing to them it has been shown that the "Kalevian" strata were more deeply penetrated by metal solutions in remote ages than had previously been thought. The prospects of discovering more ore of a similar sort are therefore very promising.

Most of the auriferous veins in Lapland that have been worked experimentally have shown a disappointingly low average content. The circumstances of the first find of rock ore at Karkelas, however, and the fact that coarse gold is found in fairly large quantities in insignificant river sources, suggest that there exist richer pockets in the rock. It is upon such a supposition that the Geological Commission has under consideration measures for further investigations.

Upon first experiments most experts believe there is a zone of gold veins under a covering "iron hood" of decomposed sulphur ore, but it is known that these coverings consist of crumbled, rusty masses whose origin had nothing to do with sulphur ore.

Gold also occurs in southern Finland in the Orijarvi district. Under the direction of Swedish experts investigations are now in progress as to possibilities there.

Platinum is occasionally mentioned as one of Finland's assets, but the unimportant grains that have been found in the rivers of Lapland do not justify any hope of platinum washing.

PRODUCTION OF PYRETHRUM FLOWERS IN JAPAN.

The peculiar properties of pyrethrum flowers, a variety of chrysanthemum (*Chrysanthemum parthenium*), which, when dried, is a deadly poison to insects, while at the same time harmless to higher animal life, including man, have made these flowers a very valuable insecticide.

Like a great many other industries in Japan, the production of pyrethrum flowers and the manufacture of insect powder greatly increased during the war. Prior to 1914 the chief sources of supply were Dalmatia, Persia, and some parts of south-eastern Europe; but during the past four years practically the world's supply has been produced in Japan. The first marked increase in production was in 1916, when the total weight of dried flowers reached 4,368,850 lb., as against 2,190,365 lb. in 1915. Before this time there was a gradual increase in production, but until the war stopped production in other countries this increase was not marked.

The acreage under production and the quantity of dried flowers produced during 1914-19 were as follows:—

	Acres.	lb.
1914 . . .	2,760	2,135,700
1915 . . .	2,800	2,190,365
1916 . . .	6,920	4,368,850
1917 . . .	10,712	6,845,208
1918 . . .	10,474*	7,720,000
1919 . . .	3,809*	2,479,680

It will be noted from the above figures that the production for the years 1917 and 1918 was very large, but that there was a great falling off in 1919.

According to a report from the American Consulate at Kobe, the centre of the pyrethrum-flower production in Japan is in the Okayama and Wakayama Kens (Prefectures) in the Kobe district, practically the entire exports being shipped from the port of Kobe.

The average size of Japanese farms is about $2\frac{1}{2}$ acres, and the average field devoted to pyrethrum flowers measures about one-third of an acre. These fields are uplands (as distinguished from paddy fields) and, owing to their small size, as well as to the limited amount of capital on which the farmers work, are entirely prepared and crop harvested by hand. The seed is usually sown broadcast, which, of course, necessitates very little cultivation, but it is also sometimes sown with

* Acreage for 1918 and 1919 is based upon the average production in 1915, 1916 and 1917, no actual statistics being available.

drills and cultivated. The average production per acre is about 651 lb.

The pyrethrum plant is a biennial, dying out at the end of the second year, and its production prohibits the use of land for other purposes during the same year. On the other hand, grasses raised for straw braids are produced in addition to a food crop, so that the return per acre planted in grasses is greater than that for pyrethrum flowers. For this reason, as well as because of the shortage of foodstuffs in Japan, many farmers formerly producing pyrethrum are turning to straw for braids.

The following statistics show the exports of dried flowers and insect powders for the six years from 1913 to 1918:—

	Flowers. lb.	Powder. lb.
1913	350,225	210,012
1914	819,612	256,566
1915	2,058,090	309,664
1916	1,811,564	557,123
1917	3,330,672	671,218
1918	3,223,845	815,050

In the year 1913 the largest foreign purchaser of the Japanese flowers was Great Britain, which took 184,930 lb., while China purchased the largest amount of insect powder, 77,084 lb. During that year the exportation to the United States amounted to only 30,376 lb. of flowers and 16,027 lb. of powder. In 1918, however, the United States was by far the largest purchaser of flowers, exports to that country amounting to 2,721,993 lb., or 84 per cent. of the total exportation. China, however, is still the leading purchaser of insect powders, exports to that country amounting to 206,682 lb. in 1918, while the export of powder to the United States amounted to but 120,949 lb., or about 14 per cent. of the total exportation.

It is estimated that the decrease in acreage caused by failure to replant will cause a decrease in the 1920 production of dried flowers to approximately 1,411,200 lb., which is less than the production in 1913.

THE OLIVE AND OLIVE-OIL INDUSTRIES IN ALGERIA.

Olive growing, it is believed, is destined to become one of the most certain sources of wealth in Algeria. The value of the trees under cultivation rises annually. The principal regions engaged are in the Department of Oran, and in that mountainous country just east of Algiers, known as Kabylia. The number of ungrafted olive trees in Algeria in the year 1912 (the latest year for which statistics of this kind are available) was 5,680,654, of which 4,097,114 belonged to natives, and 1,583,540 to Europeans.

The number of grafted trees was 7,764,568; Europeans owned 3,093,159 of these, and natives 4,671,349. In addition there are a great many wild-olive trees, some on lands belonging to the different communes, most of the rest on the public domain; these yield, for the most part, a small fruit. In fact, even the cultivated product in Algeria is still small, but, by selection and grafting, some improvement has been effected. The Forestry Service of the Government-General has had this work in hand for some time. Between the years 1911 and 1916, 32,737 graftings were made, as follows: In 1911, 7,984; 1912, 14,251; 1913, 441; 1914, 2,909; 1915, 3,096; 1916, 4,156.

Cultivation, however, is not intensive, especially on the part of the natives, as is indicated by the comparison of the number of grafted and non-grafted trees owned by Europeans and by natives. Irrigation, too, plays practically no part in the work. But, on the other hand, the ravages of the "olive fly" are said to be comparatively negligible: the Entomological Branch of the Zoological Service of the Government-General of Algeria stated in its report for 1917 that this insect was increasing but that active measures were being taken for its suppression.

Local consumption of both green and black olives is so large as to necessitate importation; the finer grades coming principally from France, while Spain supplies a considerable quantity of black olives. A large part of the Algerian crop is used in the production of olive oil, especially by the native Arabs and Kabyles, who owned and operated about 93 per cent. of the 5,123 olive-oil mills producing in 1912. According to a report by the United States Vice-Consul at Algiers, the machinery, especially in the native mills, is very primitive, and the operators are careless. This results in considerable waste, estimated to be at least 10 per cent. Some of the European mills, however, are equipped with modern appliances—such as vacuum machines for removing foreign matter from the oil.

The lack of discrimination in selecting the fruit to be used increases the naturally strong taste of the Algerian product, and necessitates its mixture with other kinds to render it palatable to Europeans, though the natives use it very much as butter is used, and employ it almost exclusively in cooking. In 1911 the yield of oil from the native presses was placed at 179,419 hectolitres (3,947,218 Imperial gallons), and in 1912 some 197,921 hectolitres (4,354,262 Imperial gallons). Only a small portion of the hulls and pulp are utilised through treatment with carbon disulphide. Since 1912 three factories have been operating in Algeria for this purpose, with a combined capacity of 20,000 metric tons per annum.

A partial remedy for the waste in the olive-oil industry is being found in co-operative mills, and also in the growing tendency of the natives to sell their product to Europeans, whose factories are better equipped. The extension of good roads will also be of benefit.

Algerian olive oil has been largely shipped to France. Tunisia has also taken a considerable amount, and treated or mixed it with its own product.

TUNGSTEN MINING IN CHINA.

The discovery of tungsten in China occurred in recent years, the deposits being found in the southern provinces, below the 30th degree of north latitude. At the present time, with a few exceptions, the mines are not owned by any private companies or by the Government, but any one may employ men to work a mine.

From a report by the United States Vice-Consul at Shanghai, it appears that the principal districts in which tungsten is found are in the Provinces of Hunan (southern part), in Hangchow and its vicinity; Kiangsi (southern part), in the Lungnanhsien, Tinnan, Sinfenghsien, Nankanghsien, and Taiyu districts; and Kwangtung (eastern part), in the Wuwha, Hingninghsien, Kaiyung, Heifung, Lukfung, and Wailia districts (northern part), in the Namyung, Lokchong, Chihing, and Chukiang districts. The districts mentioned above are only those in which operations are now being carried on, there being other large areas in which tungsten deposits are found, in the southern parts of the Provinces of Hunan and Kiangsi and the north-eastern part of Kwangtung, which have not as yet been opened.

Chinese tungsten, in the form of wolframite, occurs either as sand or pebbles in the streams or in small veins in the granitic rocks. The former deposits are sometimes accompanied by cassiterite or magnetite, or both, usually mixed with quartz sands, the latter in the form of veins ranging in thickness from a fraction of an inch to 2 or 3 inches. Although both kinds of deposits are found in many widely scattered regions, they are never found in large quantities in any particular area. For this reason, and also because this industry is of very recent origin in China, no modern systematic methods have been inaugurated to explore this field.

Rakes, toms, and pans are used for washing the stream ores, while in the case of vein ores, hand hammers, drills, and sometimes black powder are used for extracting the valuable contents of the ore. With the exception of a few places in Hunan and Kwangtung, nearly all the mining is carried on by farmers, who work during their spare time after their farming labour is completed. But during the early part of 1918 the industry had grown to such an extent that many of the farmers suspended their farm work and devoted themselves entirely to tungsten mining.

The concentrates offered on the market are rather impure, and usually have to be reconcentrated for export purposes. For this purpose a few native, as well as foreign companies have sprung up, each having a concentrating plant of some sort. One concern has a fairly well-equipped plant, containing shaking screens, jigs, rocking tables, and round revolving tables for concentrating its own ores and those collected from mining centres; and it is in a position to produce concentrates of 67–72 per cent. WO_3 with about 5 per cent. of manganese, and containing but a small amount of impurities, such as copper or tin.

The farmers take their concentrates to the local market where they dispose of them to local dealers at the best prices obtainable. The local dealers, in turn, sell them to licensed collectors from the ports. The port dealer has to pay a tax to the Government, and, after shipping the concentrates to his own port, he is under obligation to export them within a certain period, usually three months. If he fails to do this he is obliged to get another licence for the same ore or forfeit the ore to the Government.

The total exports of tungsten ore in 1918 amounted to 10,365 tons (of 2,000 lb.), but the total production during the year far exceeded this figure, there being large quantities left in the mining districts which could not be sold owing to the cessation of hostilities in Europe. The working of the deposits continued, nevertheless, until February, 1919, when it was found that the returns would not cover the cost of labour.

Up to August, 1919, tungsten ore was wholly an export product, as China had no way of utilising the ore. A plan was formulated for establishing a plant at Hankow for making ferro-tungsten, but the scheme was postponed on account of the inactivity of the tungsten market. It is understood that there is a small smelting plant at Dalny, which, however, is still in an experimental stage.

It is difficult, adds the United States Vice-Consul, even to estimate approximately the quantities of future production for any definite length of time, as, thus far, no authoritative survey has been made of this field in China. It is estimated that all the mines in the above-mentioned districts are capable of equalling their production during the year 1918 for more than ten years. Future shipments abroad will be governed entirely by the demands of the American and European markets.

NOTES ON BOOKS.

THROUGH DESERTS AND OASES OF CENTRAL ASIA. By Miss Ella Sykes and Brigadier-General Sir Percy Sykes, K.C.I.E., C.B., C.M.G. London: Macmillan & Co., Ltd. 21s. net.

In 1915 the two authors of this book travelled to Kashgar, the capital of Chinese Turkestan, where Sir Percy Sykes was to act as Consul General during the absence on leave of Sir George Macartney. Miss Sykes writes an interesting account of their journey and of their stay in Turkestan. As she has already shown in her book, "Through Persia on a Side-Saddle," she has a keen eye for a country and for the manners and customs of its inhabitants, and she has the power of conveying her impressions in a lively and readable style. The interest of this work is very considerable. The country is little known to Europeans; a European woman in many districts had never been seen before. Miss Sykes was therefore an object of at least as great curiosity to the natives as they were to her, and she has much that is amusing to tell of her encounters with them.

One of the most interesting parts of the volume is the spirited account given by Miss Sykes of the journey over "The Roof of the World." She was the first Englishwoman to cross the Katta Dawan Pass, and it was a feat that she is justly proud of. The difficulties were very great. The immense height of the pass (over 15,000 feet) causes many people to suffer from mountain sickness; the country is barren, bleak, and inhospitable, and the climate is such that in a single day the travellers suffered severely from snowstorms and from scorching heat. Only the merest track was visible in many parts, and that often led by rough and dangerous ledges overhanging frightful precipices where a slip meant certain death. For the greater part of the trail the travellers rode on ponies, but when the track became too steep they took to yaks, which in spite of their clumsy appearance contrived to keep their feet under a rider or a load of baggage where any other animal must have come to grief. Some excellent photographs give a good idea of the dangers and desolation of the Pamirs, and also of the various types of people with whom the travellers came in contact.

The second part of the book, dealing with the geography, history, customs, sport and other subjects, is the work of Sir Percy Sykes. This contains a great deal of fresh information about a little known land, which will be of special interest to the anthropologist. Here it must suffice to refer to Sir Percy's encounters with that remarkable creature, the *Ovis poli*. When Marco Polo returned from his travels, he told tales of wild sheep on the Pamirs of enormous size, "whose horns are good six palms in length." Nobody believed him. How could such creatures pick up a living in a country where vegetation was of the scantiest? However, time has justified Marco Polo in this, as in most of his stories. Sir Percy Sykes shot several of these sheep, and he tells us: "The height at the shoulders exceeds 12 hands, and the weight may be about 22 stone. The length of the horns is enormous, one specimen, believed to be the longest on record, measuring 6 feet 3 inches! Marco's 'six palms' may perhaps be the equivalent of 5 feet; so that his estimate is in no way exaggerated." It is satisfactory that just, if tardy, reparation has been made to the memory of the great traveller by calling this animal *Ovis poli*, Polo's sheep.

This work may be warmly commended to all who love books of travel. It should possess a special interest for readers of the *Journal*, for both the authors are Fellows of the Society, and both have read papers here.

GENERAL NOTE.

THE RUBBER GROWERS' ASSOCIATION PRIZES.—The Rubber Growers' Association (Incorporated) offer the following awards for ideas and suggestions for extending the present uses or for encouraging new uses of rubber: One prize of £1,000: three prizes of £500 each: ten prizes of £100 each: a sum not exceeding £1,500 to be divided amongst the remaining Competitors whose suggestions are considered to be of value, according to the relative value of their suggestions, but so that no competitor will receive more than £100. Suggestions must be practical and likely to increase the demand for the raw material. Ideas will be welcomed for the application in new directions of existing processes, methods or manufactures, or for improvements or new processes which will facilitate or cheapen the production of rubber goods. Competent judges (technical and otherwise) will be appointed to investigate and adjudicate upon the suggestions received. All enquiries in connection with the Competition (other than the Competitive Suggestions) should be addressed to The Rubber Growers' Association (Dept. C.), 38, Eastcheap, London, E.C. 3.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, JUNE 21...Geographical Society, 135, New Bond-street, W., 8.30 p.m. Major L. F. I. Athill, "Through South-West Abyssinia to the Nile."

British Architects, Royal Institute of, 9, Conduit-street, W., 8 p.m.

TUESDAY, JUNE 22...Aeronautical Society, Central Hall, Westminster, 8.30 p.m. (Wilbur Wright Lecture.) Commander J. C. Hunsaker, "Naval Architecture in Aeronautics."

East India Association, 7A, Tothill-street, Westminster, 4.30 p.m. Mr. P. J. Hartog, "The Work of the Calcutta University Commission."

Pottery and Glass Trades Benevolent Institution, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Annual Meeting.

WEDNESDAY, JUNE 23...Electrical Engineers, Institution of, Wireless Sectional Meeting, at Institution of Mechanical Engineers, Storey's-gate, S.W., 6 p.m. Mr. B. S. Gossling, "The Development of Thermionic Valves for Naval Uses."

Nurse's Pension Fund, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m.

Geological Society, Burlington House, W., 5.30 p.m. Mr. O. Holtedahl, "The Scandinavian Mountain Problem."

University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Professor A. J. Toynbee, "Islam and the Caliphate (6th to 11th century A.D.)."

THURSDAY, JUNE 24...Incorporated Society of Trained Masseuses, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 6 p.m. Sir Charles Ballance, "Healing Process in Nerves."

University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Sir E. Denison Ross, "Gujarat in the time of Akbar."

Medicine, Royal Society of (Laryngology Section), Summer Congress.

Royal Society, Burlington House, W., 4.30 p.m.

Antiquaries, Society of, Burlington House, W., 8.30 p.m.

Linnean Society, Burlington House, W., 5 p.m.

FRIDAY, JUNE 25...Incorporated Society of Trained Masseuses, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 6.30 p.m. Miss M. Bond, "Some Factors influencing Nutrition and Growth."

Medicine, Royal Society of (Laryngology Section), Summer Congress.

Physical Society, Imperial College of Science, South Kensington, S.W., 5 p.m.

Journal of the Royal Society of Arts.

No. 3,527. VOL. LXVIII.

FRIDAY, JUNE 25, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

FINANCIAL STATEMENT FOR 1919.

The following statement is published in this week's *Journal* in accordance with Sec. 40 of the Society's By-laws :—

INCOME AND EXPENDITURE ACCOUNT,

January 1st to December 31st, 1919.

Dr.

	£ s. d.	£ s. d.	£ s. d.
To *Journal*, including Printing, Publishing, and Advertisements...		2,851 11 10	
,, Library and Bookbinding...........		96 10 5	
,, Medals :—			
Albert	21 15 0		
Society's	16 18 0		
		38 13 0	
,, Sections :—			
Colonial	64 13 5		
Indian	98 9 10		
		163 3 3	
,, Cantor Lectures		167 3 11	
,, Donation to Board of Scientific Societies		10 10 0	
			3,327 12 5
,, Expenses of Examinations			4,940 19 2
,, House—			
Rent, Rates, and Taxes		921 12 11	
Insurance, Gas, Coal, Expenses and Charges incidental to Meetings		413 19 9	
Repairs..............................		113 6 7	
			1,478 19 3
,, Office Expenses :—			
Salaries, Wages, and Pensions		2,999 15 10	
Stationery and Office Printing		539 14 7	
Advertising..........................		69 13 0	
Postages, Parcels, and Messengers' Fares		211 3 3	
			3,870 6 8
,, Committees :—			
General Expenses			42 13 0
,, Interest on Bank Loan			102 18 9
,, Juvenile Lectures			20 0 0
			£13,783 9 3

Cr.

	£ s. d.	£ s. d.
By Subscriptions	5,437 16 0	
,, Life Compositions	823 18 0	
		6,261 14 0
,, Interest and Dividends on Society's Investments	492 18 4	
,, Ground Rents	366 5 0	
,, Interest, Dividends, and Ground Rents from Trust Funds for General Purposes	501 11 1	
Do. from Building and Endowment Funds..........................	22 7 5	
		1,383 1 10
,, Sales, etc. :—		
Journal	197 2 9	
Do. Advertisements	95 12 6	
Cantor Lectures.....................	23 11 5	
		316 6 8
,, Examination Fees and Advertisements in and Sale of Examination Papers		4,934 11 7
,, Charges for Expenses for the Use of Meeting Room		263 3 6
,, Balance, being Excess of Expenditure over Income transferred to Capital Account (see Balance Sheet)		621 11 8
		£13,783 9 3

TRUST INCOME AND EXPENDITURE ACCOUNTS.

Dr.

	£ s. d.
To Balance forward	410 1 7
	£410 1 7

Cr.

	£ s. d.	Trust Accumulations December 31st, 1919. £ s. d.
John Stock Trust—		
By Balance, January 1st, 1919	18 5 9	
,, Interest on Investments	3 10 2	
		21 15 11
North London Exhibition Trust—		
,, Balance, January 1st, 1919	27 14 11	
,, Interest on Investments	6 14 10	
		34 9 9
Dr. Aldred's Trust—		
,, Balance, January 1st, 1919	23 11 11	
,, Interest on Investments	7 14 5	
		31 6 4
Thomas Howard's Trust—		
,, Balance, January 1st, 1919	56 18 3	
,, Interest on Investments	20 2 1	
		77 0 4
Owen Jones Memorial Trust—		
,, Balance, January 1st, 1919	78 4 5	
,, Interest on Investments	15 13 4	
	93 17 9	
Less Cost of Medals	8 7 8	
		85 10 1
Mulready Trust—		
,, Balance, January 1st, 1919	47 6 1	
,, Interest on Investments	5 5 4	
		52 11 5
Dr. Swiney's Trust—		
,, Balance, January 1st, 1919	200 0 0	
,, Ground Rents (Income from)	180 0 0	
	380 0 0	
Less Cost of Cup and Prize £200 0s. 0d.; *Less* Transfer to the Society's Income and Expenditure Account £140 0s. 0d.	340 0 0	
		40 0 0
Francis Cobb Trust—		
,, Balance, January 1st, 1919	11 18 1	
,, Interest on Investments	8 18 10	
		20 16 11
Le Neve Foster Prize Trust—		
,, Balance, January 1st, 1919	7 11 4	
,, Interest on Investments	5 16 0	
		13 7 4
Fothergill Trust—		
,, Balance, January 1st, 1919	8 2 2	
,, Interest on Investments	13 12 5	
		21 14 7
Trueman Wood Lecture Trust—		
,, Balance, January 1st, 1919	3 11 7	
,, Interest on Investments	32 14 8	
	36 6 3	
Less Cost of Sir Herbert Jackson's Lecture	25 0 0	
		11 6 3
Benjamin Shaw Trust—		
,, Interest on Investments	4 13 6	
Less Balance overspent, January 1st, 1919	4 10 10	
		0 2 8
Cantor Trust—		
,, Interest on Investments	142 8 5	
,, Ground Rents (Income from)	141 0 0	
	283 8 5	
Less Transfer to the Society's Income and Expenditure Account	283 8 5	
		—
Davis Trust—		
,, Interest on Investments	78 2 8	
Less Transfer to the Society's Income and Expenditure Account	78 2 8	
		—
		£410 1 7
1920. Jan. 1. By Balance brought forward		£410 1 7

BALANCE SHEET, December 31st, 1919.

Dr.

	£ s. d.	£ s. d.
To Capital Account :—		
As on January 1st, 1919 ...	23,742 2 3	
Plus Increase in Value of Pictures, etc.	5,000 0 0	
	28,742 2 3	
Less Income and Expenditure Account Balance	621 11 8	
		28,120 10 7
,, Bank Loan		1,900 0 0
,, Trust Funds :—		
Capital Account	15,999 7 5	
Accumulations under Trusts Income and Expenditure Account.........	410 1 7	
		16,409 9 0
,, Sundry Creditors		3,333 12 8
		£49,763 12 3

Cr.

	£ s. d.	£ s. d.
By Investments (see Schedule) :—		
As on December 31st, 1917 (as valued at May 31st, 1917)		19,961 0 5
,, Property of Society (Books, Pictures, etc.)		10,000 0 0
,, Trust Funds Investments (at cost, see Schedule)		15,999 7 5
,, Ground Rents outstanding :—		
Trust Account	97 0 0	
Society's Account...............	170 12 0	
		267 12 0
,, Subscriptions outstanding........................		1,740 0 0
,, Sundry Debtors :—		
Journal	52 0 10	
Advertisements	110 12 6	
Repayment of Expenses for use of Meeting Room	117 12 0	
Income Tax recoverable......	383 19 9	
		664 5 1
,, Cash at Bank on Current Account (less Cash in transit)		731 7 4
,, do. on Deposit......................................		400 0 0
		£49,763 12 3

We have audited the above Accounts and Balance Sheet for 1919 *with the books, accounts, and vouchers relating thereto, and certify them as being in accordance therewith. We have verified the Bank Balances and investments.*

KNOX, CROPPER & CO.,
Chartered Accountants.

Spencer House, South Place, E.C. 2.
21*st June*, 1920.

SCHEDULE OF THE SOCIETY'S INVESTMENTS.

		£ s. d.
	Ground-rents (amount invested)	£10,496 2 9
£217 0 0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock ...	158 8 0
£500 0 0	New South Wales 4 per Cent. Stock............................	415 0 0
£500 0 0	Canada 3½ per Cent. Stock	360 0 0
£100 0 0	Queensland 4 per Cent. Stock..................................	80 0 0
£530 10 1	New South Wales 3½ per Cent. Stock	456 5 0
£500 0 0	Natal 4 per Cent. Stock	400 0 0
£321 15 9	Metropolitan Water Board "B." Stock..........................	196 6 0
£6 0 0	New River Company Shares	6 0 0
£3,000 0 0	Newcastle-on-Tyne 3½ per Cent. Stock	2,775 0 0
£3,408 14 6	India 3½ per Cent. Stock	2,317 18 8
£500 0 0	South Australia 4 per Cent. Stock..............................	400 0 0
		18,061 0 5
£2,000 0 0	War Loan 5 per Cent.	1,900 0 0
		£19,961 0 5

TRUST FUNDS INVESTMENTS SCHEDULE.

Alfred Davis's Bequest	£1,953	0	0	Great Indian Peninsula Railway 4 per Cent. Guaranteed Debenture Stock	£1,800	0	0
Mr. Swiney's Bequest	4,477	10	0	Ground-rents (amount expended)	4,477	10	0
Mr. Cantor's Bequest	2,695	11	3	Do. do do.	2,695	11	3
Mulready Trust	105	9	9	National 5 per Cent. War Bonds 1927	109	10	1
Howard Trust	571	0	0	Metropolitan Railway 3½ per Cent. Stock	510	9	5
Owen Jones Trust	522	3	2	India 3 per Cent. Stock	423	0	0
Mr. Cantor's Bequest	3,273	16	6	Do. do.			
	648	19	7	Bombay and Baroda Railway Guaranteed 3 per Cent. Stock	2,573	10	0
J. Murray and others, Building Fund	20	16	4	India 3½ per Cent. Stock	20	10	0
	38	11	0	5 per Cent. War Loan	54	18	0
Francis Cobb Trust	255	14	1	New South Wales 3½ per Cent. Stock 1930-50	250	0	0
Le Neve Foster Trust	105	11	7	3½ per Cent. War Loan	100	0	0
	42	2	1	5 do. do.	40	0	0
John Stock Trust	70	4	0	5 do. do.	100	0	0
Shaw Trust	93	12	0	5 do. do.	129	6	8
North London Exhibition Trust	134	17	0	5 do. do.	184	15	0
Fothergill Trust	272	7	6	5 do. do.	374	0	0
Aldred Trust	154	8	0	5 do. do.	210	17	6
Endowment Fund	394	7	0	5 do. do.	525	2	3
"Trueman Wood" Lecture Endowment Fund	654	15	7	National 5 per Cent. War Bonds 1928	654	18	0
Sir George Birdwood Memorial Fund	734	19	9	5 per Cent. War Loan	674	0	0
Russian Embassy Prize	100	0	0	5 do. do.	91	9	3
					£15,959	7	5

NOTICES.

ANNUAL GENERAL MEETING.

The Council hereby give notice that the One Hundred and Sixty-sixth Annual General Meeting, for the purpose of receiving the Council's report and the Financial Statement for 1919, and also for the election of Officers and new Fellows, will be held, in accordance with the By-laws, on Wednesday, June 30th, at 4 p.m.

At the Annual General Meeting the Council will propose the following Resolution:—

1. That By-Law No. 56, relating to the annual subscription of members be altered and amended by the substitution of the word *Three* for the word *Two*.

2. That By-Law No. 59, relating to Life Compositions, be altered and amended by the substitution of the word *Thirty* for the word *Twenty*.

The By-Laws, as amended, will then read as follows:—

By-Law 56.—"The Annual Subscription of every member shall be *Three* guineas at least."

By-Law 59.—"Any member may commute or compound for all future payments, and become a member for Life, by payment of a sum of not less than *Thirty* guineas."

(By order of the Council),

GEORGE KENNETH MENZIES,
Secretary.

INDIAN SECTION.

FRIDAY, JUNE 18th; THE RIGHT HON. LORD MESTON, K.C.S.I., LL.D., in the chair. The first Sir George Birdwood Memorial Lecture on "The Enduring Power of Hinduism" was delivered by SIR VALENTINE CHIROL.

The lecture will be published in a subsequent number of the *Journal*.

PROCEEDINGS OF THE SOCIETY.

TWENTY-FIRST ORDINARY MEETING.

WEDNESDAY, MAY 19th; MR. ALAN A. CAMPBELL SWINTON, F.R.S., Vice-President of the Society, in the chair.

The paper read was—

THE COMMERCIAL APPLICATION OF ELECTRICAL OSMOSIS.

By JOHN SOMERVILLE HIGHFIELD, M.Inst.C.E., M.I.E.E.; W. R. ORMANDY, D.Sc.; and D. NORTHALL-LAURIE, F.I.C.

The study of matter in the colloidal state is one of the first importance and is of surpassing

interest. The problems resolve themselves into the scheming of methods of studying the rate of movement and the causes of movement of particles of very small size often approaching

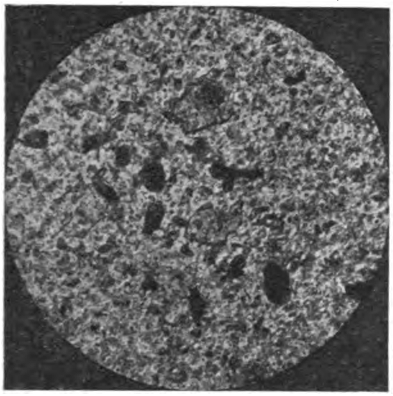

FIG. 1.
CHINA CLAY FROM CORNWALL, AFTER ORDINARY TREATMENT.
Magnified 150 times.

molecular dimensions. The forces causing movement are molecular, chemical, and electrical, added to the force of gravitation, and the movements may take place in any medium, but usually in water. The importance of the subject is apparent when it is realised that many of the largest trades and manufactures depend on the use and proper treatment of matter in the colloidal state. Agriculture depends on a suitable colloidal state of the soil, tanning of leather on the introduction into the cells of matter in colloidal form. The glue and gelatine industry deals with colloidal matter. The dyeing of fabrics consists largely in introducing finely divided material into fibrous matter. Again, by a scientific study of their slimes the efficiency of the recovery of metals can be increased. Papermakers deal with matter in a colloidal state. Trades so diverse as dairy production and paint manufacture are equally concerned in the treatment of colloidal matter.

The terms colloid or matter in a colloidal state, true solution and suspension, are not easy of simple definition. For the purpose of the immediate subject, matter in a colloidal state or a colloid means matter in so fine a state of division that it tends, under favourable circumstances, where coalescence does not readily take place, to remain for some hours in suspension.

The term Osmosis, or Osmose, appears to have been first used by Graham about 1854; it may have been derived from the Greek word Osmos, meaning "pushing," and the terms Exosmosis and Endosmosis, used by Dutrotchet about 1800, refer to a pushing outwards or inwards, osmosis being a general pushing such as the diffusion of liquids through a diaphragm. The importance of the phenomenon has long been recognised as it is one consistently occurring in living bodies, both animal and vegetable. The first record appears to be by Nollet (1700–1770) as a result of experiments with water and alcohol through a bladder. Dutrotchet investigated the subject, and his work resulted in numerous applications in methods of dialysis by Graham. Graham insisted that the phenomenon was molecular, and that it is due to the raising of sap in trees against gravity.

Graham, in 1861, found that when a weak solution of sodium silicate was poured into excess of hydrochloric acid no precipitate was formed, whereas, if the sodium silicate solution was strong, a gelatinous precipitate of silica was obtained.

He found that by placing this clear solution in a small dish made of parchment, and floating it in water the sodium chloride produced by the reaction passed through the pores of the parchment paper, and, by frequent changes of the surrounding water, could be completely re-

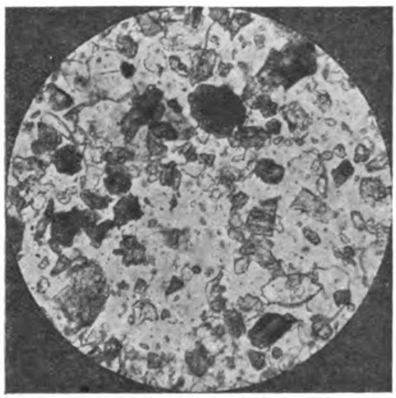

FIG. 2.
LARGE PARTICLES OF MICA, SILICA AND ROULEAUX CONSISTING PROBABLY OF KAOLINITE REMOVED BY THE PROCESS.
Magnified 150 times.

moved, leaving inside the dish the silicic acid, thus proving that it was not an ordinary solution.

Graham called the silicic acid when in this

condition a *Colloid*, whereas he termed the salts and other similar bodies that passed through parchment *Crystalloids*, and the separation of one from another *Dialysis*.

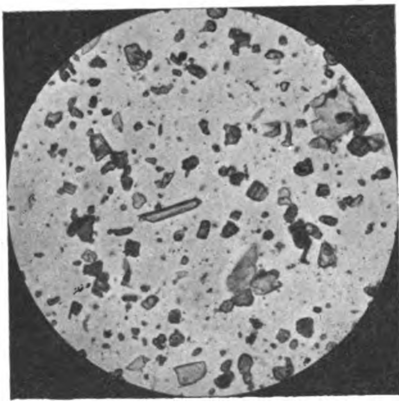

FIG. 3.
SMALLER PARTICLES OF IMPURITIES REMOVED IN THE OSMOSIS MACHINE.
Magnified 150 times.

These original definitions have been extended and amplified. A colloidal solution is termed a *Sol*, and, if water is the liquid in which it is contained, the sol is known as a *Hydrosol*; if alcohol, an *Alcosol*, or generally an *Organsol* if the medium is some organic liquid.

The colloidal substance is termed the *Disperse Phase*, whereas the medium in which it is dispersed is termed the *Disperse Medium*. Most materials, including metals, sulphides, oxides and salts can exist in the colloidal state. Natural substances occurring in very small particles such as Ball clay, China clay, and the various types of Fire clay, can be brought into the colloidal condition by suitable means, and most naturally occurring compounds as Emery, Quartz or Steatite, and the artificial abrasives, Carborundum and Alundum, can be rendered colloidal by sufficiently fine grinding.

The existence of a material present in the colloidal state in a so-called solution can be demonstrated in various ways. For instance, when the colloidal particles are extremely minute their presence as particles can be shown either by dropping upon filter paper when the colloidal matter will remain as a stain in the centre, the disperse medium, in this case water, spreading out round it; or by passing a powerful beam of light through the liquid when the particles will cause the path of the beam to become visible, and the light reflected from the particles to be polarised. This experiment was first shown by Tyndal, and is known as the Tyndal effect.

Electrical Properties of Colloidal Solutions.—Picton and Linden found that matter in colloidal suspension, when subjected to direct current of upwards of sixty volts between platinum electrodes, tended after a time to collect either around the anode or cathode, leaving a clear space around the cathode or anode respectively.

They investigated this phenomenon and found it to be of general occurrence. It is known as Electrical Osmose or Cataphoresis, and the polarity of the particles depends not only upon the constitution of the particles but on the nature and quantity of electrolytes present, and also upon the composition of the disperse medium in which they are suspended as the disperse phase. Thus, silicic acid is charged positively when in water, and negatively when in turpentine.

Generally, the continual suspension of a colloid in the disperse medium is possible only when the colloidal particle retains an electrical charge. The particles possessing the charges of the same sign, either positive or negative, repel each other, and so cannot coalesce or coagulate together.

They can be made to coalesce by subjecting them to an electric field by means of immersed electrodes, when they are attracted to the pole of sign opposite to their charge, and are so discharged; this is the industrial method used in the purification of clay.

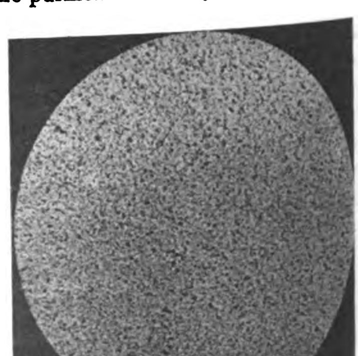

FIG. 4.
THE OSMOSED PRODUCT.
Magnified 150 times.

They can be made to coalesce by adding to the liquid an equal number of colloidal particles of opposite charge, when the two sets of particles mutually discharge one another. As

an example, the addition to a colloidal suspension of arsenic sulphide of a colloidal suspension of a basic material, such as ferric hydrate, causes the precipitation of the two colloids.

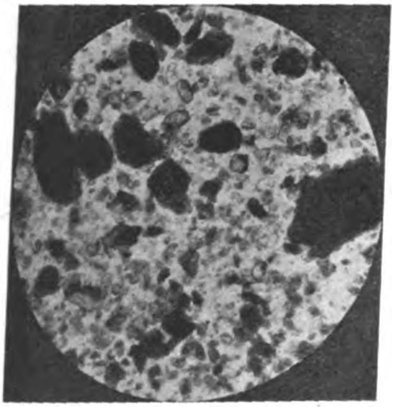

FIG. 5.
STAFFORDSHIRE MARL, AFTER WEATHERING.
Magnified 150 times.

The quantity of one colloid required completely to precipitate another colloid of opposite charge varies with the composition of the precipitating colloid. Biltz gives the following figures: 1·4 m.g. of gold is completely precipitated by:—

4 m.g. of cerium oxide;
3 m.g. of ferric oxide;
2·5 m.g. of thorium oxide;
1·6 m.g. of zirconium oxide;
0·3 m.g. of chronic oxide;
0·1 to 0·2 m.g. of alumina.

The order of power of precipitation varies with the substance to be precipitated, and depends probably upon the absorption capacity of the material.

Another method of bringing about the coagulation of peptised particles is to add to the suspension a small quantity of a salt which in solution is subject to electrolytic dissociation. If the peptised particles carry an electronegative charge, then the added electrolyte must be electro-positive; thus, bodies which are peptised by an alkali are precipitated by an acid.

The deposition of the fine silt and mud carried down by rivers when the stream encounters the salt of the sea is, no doubt, due to the flocculation of the dispersed particles by the salt electrolyte.

In order that the phenomenon of electrical osmose can be shown, it is necessary first that the colloidal material in suspension should be broken up by giving each minute particle an electrical charge, thus preventing coalescence, that is to say the suspension should be peptised.

Various materials can be peptised, each requiring different peptising agents: thus, gelatine is peptised by hot and not by cold water; gums by cold water; mastics in alcohol by large quantities of water; metals by fused metallic salts; hydrous oxides by caustic alkali.

The special application of these principles, to which we wish particularly to refer, is the purification of clay and similar materials. The commercial application of these phenomena to the purification of clay is due to the late Count Schwerin. He showed that the addition of small traces of alkali to a suspension of clay in water resulted in the suspension becoming highly mobile, the clay particles remaining for a long time in suspension, the pyrites, mica, free silica, and other impurities which are not peptised, tending to fall through the suspension.

Count Schwerin, in his patent specification, points out that bodies in suspension which tend to move to the cathode, require an electrolyte of an acid character to be employed to bring about dispersion or peptisation, but that bodies which tend to move to the anode require electrolytes of an alkaline character. It is further of interest to note that the original inventor not only shows that the addition of suitable electrolytes can be used to peptise the

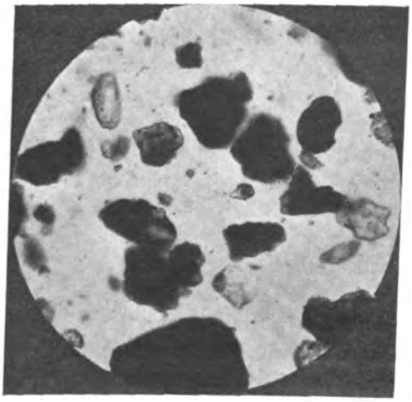

FIG. 6.
IMPURITIES CONSISTING OF PYRITES AND SAND REMOVED.
Magnified 150 times.

main matter in suspension, to bring about increased fluidity with the object of allowing foreign matter to separate out by subsidence, but he also points out that if one substance is

present in varying degrees of fineness, it is possible by the utilisation of the same principles to bring about a separation of the fine particles from the coarse ones.

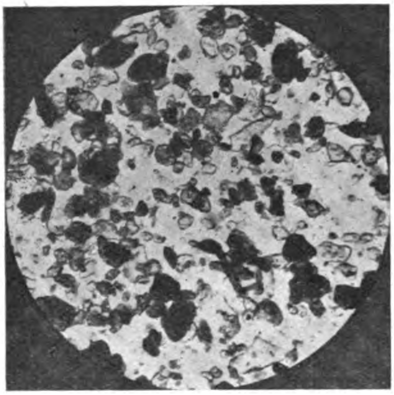

FIG. 7.
FINER IMPURITIES REMOVED BY THE MACHINE.
Magnified 150 times.

Coalescence of the peptised particles in a clay slip can be produced by discharging the particles by the addition of acid to the suspension; the clay then settles in a gummy flocculated mass, carrying with it the fine impurities as previously explained. The action of the acid and alkali on the slip can be illustrated by reversing the method and allowing a thin stream of neutral clay slip to flow into a vessel containing on the one hand acid, and on the other alkali; in the first, the clay particles fall in a continuous solid stream and settle quickly; in the second, the clay particles spread out broadly and settle very slowly.

There are many disadvantages to the flocculation of the clay by coagulating with electrolytes; certain fine impurities remain in suspension and are carried down with the flocculated clay, so that only partial purification is attained. The physical state of the clay is entirely altered, and the clay is left in a form difficult to collect and dry. For these reasons, the electrical method of purification was developed.

If, in the prepared suspension, two electrodes are immersed, and a difference of electrical potential be established between them, the clay particles move to the anode, where they discharge themselves and adhere as a coagulated mass, and the water is driven to the cathode, leaving the clay in a semi-dry state attached to the anode. The fine particles of silica, mica, pyrites, and other impurities, either migrate to the cathode or are washed away by the water stream moving to the cathode.

This is an example of using a direct electrical pressure to produce coalescence in a peptised suspension.

The effect of the practical application of the process on clay is to remove particles of mica, silica, pyrites, and felspar, and to leave the clay substance in a satisfactory state for final drying. The effectiveness of the purification is illustrated by reference to photo-micrographs, Figs. 1-11.

It is, perhaps, allowable at this stage to indicate some of the directions in which the osmotic treatment of clay leads to advantages, having a direct and practical bearing upon industry. It is not realised sufficiently that the melting point of pure clay substance is higher than that of any admixture of clay substance with silica, although it is commonly known that the other ingredients generally present in mined clay, such as pyrites, mica, felspar, and the like, are very active in reducing the melting point. The more finely divided the silica and other impurities, the more intense the action in bringing about the softening of the clay substance at high temperatures, for the fine state of division brings about a great area of active contact surface. It is this fine material that cannot be removed by settling, and which the Osmosis process successfully eliminates.

The sintering or vitrifying temperature of a

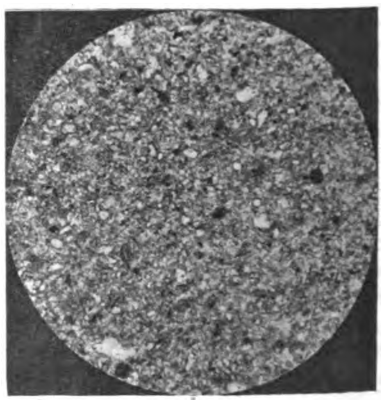

FIG. 8.
OSMOSED PRODUCT CONSISTING ALMOST WHOLLY OF CLAY PARTICLES.
Magnified 150 times.

clay may be taken to be the temperature at which the rapid contraction of the clay in firing ceases; above this point little contraction occurs. Sintering takes place in osmosed clays

at lower temperatures than in the raw clays; consequently, goods made with osmosed clay can be finished at lower temperatures, resulting in a saving of fuel. The reduction of the

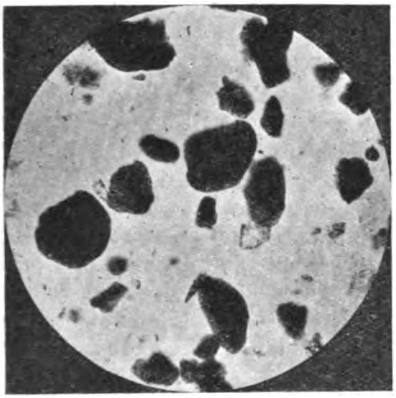

Fig. 9.
Impurities removed from a fine quality Ball Clay.
Magnified 150 times.

sintering temperature, together with the higher melting-point, enables articles to be made that show little further contraction after burning. The amount of the reduction of the sintering temperature varies for different clays; it is as much as 300° C. for low-grade clays, and much less for high-grade clays. Bricks made from some clays, after osmosing, are better burnt at 1,100° C. than from the raw clay at 1,300° C.

Many alluvial red-burning clays cannot be fired to vitrification because, before vitrification temperature is reached, the clay commences to blow. Many such clays, after the osmosis treatment, have a margin of from 100° to 200° C. between the vitrifying temperature and the temperature at which decomposition starts. This enables vitrified bricks and vitrified roofing tiles to be made from a product which, without treatment, could not be used for such purpose.

In the manufacture of porcelain and earthenware, osmosed clays yield whiter bodies or bodies freer from specks and stains. Osmosed fireclays are entirely free from pyrites, and goods made therefrom are not subject to green stains when glazed.

By the use of fine osmosed materials, chemical porcelain has been produced of the highest quality, the body being made of pure kaolin only, which, owing to the fineness of the particles, completely vitrifies; the locking of the glaze to the body by the fine sillimanite crystals, which form on firing and penetrate the glaze, is shown in the photo-micrograph, Fig. 12.

The form given to the apparatus for the commercial purification of clay consists of a tank of suitable form, containing at the lower part two paddles, which serve to keep the suspension in agitation, and which direct it in a stream through the numerous small spaces in the cathode fixed immediately above, surrounding the lower half of the anode. The anode consists of a metal cylinder, revolving at a speed of about one revolution in three minutes, at a distance of about three-quarters of an inch from the cathode. A scraper removes the clay from the anode, whence it falls down a shute clear of the machine. The fresh clay suspension is fed into the lower part of the container, and the water effluent returned to be mixed with fresh clay. A machine with a cylinder, two feet diameter and five feet long, produces about 1,000 tons of pure clay per annum.

The manner in which the machine acts towards the clay slip is as follows:—

The clay in suspension, in passing through the laminated or perforated cathode, becomes negatively charged and is immediately attracted to the anode cylinder, the water being driven towards the cathode. There is thus obtained a dry layer of clay on the anode cylinder and a watery zone of clay suspension round the cathode. Fresh clay entering the machine encounters the watery zone on its passage to

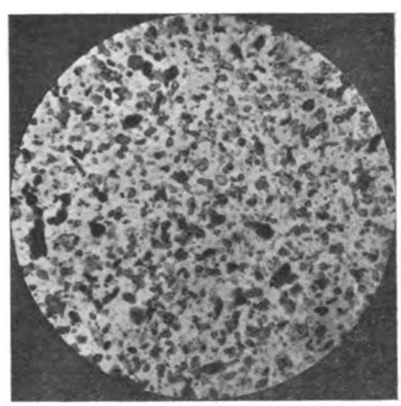

Fig. 10.
Fine Impurities removed by the Osmosis Machine.
Magnified 150 times.

the anode, in which zone the electro-osmotically indifferent particles such as pyrites, mica, and quartz, become freed from the clay, and are washed away with the effluent from the

machine. The effluent with these particles also contains some clay. It is carried to a settling tank where the impurities quickly settle out, and thence to a blunger, or other

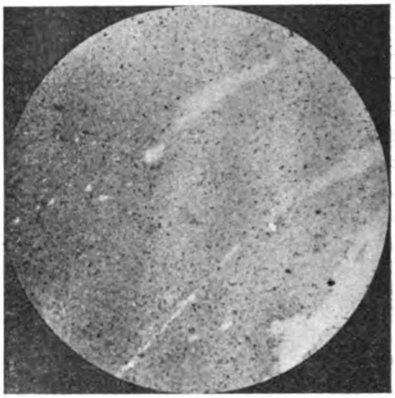

FIG. 11.
THE OSMOSED PRODUCT.
Magnified 150 times.

mixing machine, where it takes up fresh clay and returns again to the machine through one or more settling tanks.

The clay leaves the machine in the form of a blanket from one-quarter to one-half of an inch in thickness, from which all the water has been driven except about 25 per cent., and in this form admits of ready drying when required. The process is extraordinarily flexible and, therefore, lends itself to the treatment of many varieties of clay from which many different products are obtained. From some marls and fireclays, considerable quantities of pyrites are obtained, and from others silica in a very finely divided form is separated. From china clay deposits, exceedingly fine mica and sand are obtained. Again, the clay particles themselves vary greatly in fineness, and the very fine particles can be separated from the coarser. This exceedingly fine clay is useful for many purposes, and doubtless many new applications for its use will arise. The finest particles of ball clay are almost jelly-like in fineness.

The cost of working varies widely according to the class of clay treated. The electricity used varies from as low as 20 up to 70 units per ton of machine product.

Another application of electro-osmosis is the electro-osmotic filter press, which has been developed for the de-watering and purifying of many substances in a finely divided state. The press in its simplest form consists of a series of chambers into which the suspension is fed under a head of, say, 10 ft., sufficient to ensure a rapid filling of the chambers. The chambers are closed on both sides by filter cloths in the ordinary way, but the cloths are held in position by perforated or grooved metal or carbon or other conducting plates, one of these plates forming a cathode and one an anode. An electrical pressure of 20 to 100 volts, depending on the substance to be filtered, is established between the plates, and the water is forced towards the cathode. In this press, very fine materials can be de-watered, materials fine enough to choke the ordinary press. This press can be used for filtering clays and many other materials in a colloidal state which are difficult to filter in the ordinary pressure press.

The application of the principles of electrical osmosis are by no means confined to the purification of clay. The applications are, in fact, so many that it is possible in the time at our disposal to refer only to a few examples, such as the tanning of leather, the treatment of metallic slimes produced in various stages of metal purification. The removal of ash from gelatine and the separation of glue and

FIG. 12.
FRAGMENT OF CRUCIBLE, THE BODY MADE OF PURE KAOLIN, GLAZED WITH VERY REFRACTORY GLAZE, SHOWING SILLIMANITE CRYSTALS LOCKING THE GLAZE TO THE BODY. THE DARK PARTS ARE THE BODY.
Magnified 1,000 times.

gelatine into several products has been accomplished.

[The paper was illustrated by a large number of lantern slides and experiments.]

DISCUSSION.

The Chairman (Mr. A. A. Campbell Swinton), in introducing Mr. Highfield, who read the paper, said the subject of electrical osmosis was one that was partly chemical, partly electrical, and partly physical, and in its applications came into the region of engineering, so that it was perhaps reasonable that three authors should have taken part in the paper—Mr. Highfield, who was a member of the Council of the Society and well known in the electrical world, Dr. Ormandy, who was well known in the chemical world and had previously lectured before the Society, and Mr. Northall-Laurie, who was also a distinguished chemist.

Sir Herbert Jackson, K.B.E., F.R.S., said he had bean always interested in electrical osmosis, and at the time during the war when there was some anxiety as to the supply of glass, the hope of getting something better in the way of pots for optical glass was of importance, and it was realised that if the lines pointed out in the paper could be followed it would be of great benefit. The facts were very simple and clear with regard to the advantages of the clay. In his own case, in using an ordinary and well-known form of clay crucible or muffle for experiments, he was very lucky if he could ensure getting anything like 24 hours' work out of it, but it was quite easy to obtain something in the order of ten or fifteen times as much work out of a muffle that was produced from the osmosed clay. He exhibited two specimens of crucibles which had been given to him by the authors, one of which had been baked at a temperature between 800° and 1,000°, and the other had been used as an experiment to see how far it would contract at a higher temperature, and inside it and fused into a mass that was quite soft was some of the clay of a crucible that he at one time used, so that the ordinary clay crucible had fused inside the authors' crucible. When the crucible was being taken out of the furnace, which had a pure silica lining, it had to be lifted out with considerable force, and the silica was drawn out in fine rods, but it was not possible to deform the clay crucible even in taking it out with considerable force. When material was in a fine state of division, so that each particle could exercise its best attraction on the neighbouring particles, a condition of equilibrium and great stability was reached, and when there was stability under heat there was also stability under chemical action for most things. There was great hope that many things which had been difficult to prepare with ordinary clay could be prepared in a state of greater purity and more readily when the process of the osmosed clay was understood thoroughly and became regularly used. He had had the pleasure of meeting Dr. Ormandy and Mr. Highfield some time ago, and took the whole matter up with Dr. Ormandy, and they started out and achieved the brilliant success they had shown that evening, and he felt confident it would be as brilliant a success when carried out on a large scale.

Mr. Walter C. Hancock said those who had had any experience in the preparation of a lecture for such an audience would be very much impressed with the magnificent show the authors had given. The photographs, taken under very high magnification, were really quite triumphs of art. He did not think he would be giving away any secrets if he said that he came to the meeting that afternoon from a place where they had been more or less discussing the problem of the production of glass, and he was happy to say that the production of high-grade optical glass of all descriptions, was now being wrested by this country from many former competitors, and success would depend entirely upon the utilisation of some high-grade refractory material. Up to the present, manufacturers had been content to take the raw material as it was mined and submit it to the most primitive methods of purification. The osmosis process would supersede any method employed hitherto for the production of high-grade china clay and other forms of clay, and a material would be obtained which was capable of resisting the effects of high temperature on the one hand and of chemical action upon the other.

Mr. W. Murray Morrison said he had seen a large number of samples of osmosed clay, and he believed there was a very large field of application for that clay in this country; in fact, it would seem that the field was almost unlimited. The Society was very much indebted to the authors for having brought the subject forward.

Mr. W. H. Patchell said the slides shown on the screen were very beautiful, but the specimens were more fascinating still when seen under the microscope. With regard to the question of colloids, he thought the first strike on record was due to colloid chemistry, when the Egyptians cut off the supply of straw from the Israelites for making bricks. In 1910 he saw the work on osmosis being carried out by Count Schwerin in Germany, and he sent some samples of clay from Cornwall and received most beautiful results from the Count, but he did not appreciate at that time what those samples really meant. They showed a finer clay than could be produced by the ordinary method adopted in Cornwall, but there was no demand in this country for such beautiful products; it was said not to be commercial and so was turned down. About three years later he had one or two interesting interviews with Dr. Ormandy, and after that Sir Herbert Jackson took the matter up. The Cornishman, though generally a Radical, was a most conservative man in his methods. The ordinary Cornish clay washing had gone on with practically no change whatever, and when the offer was made to show the Cornishman better methods it was very difficult to get him to move, and as he could sell more clay than he had been able to produce he really could not be blamed. The difficulty now was not in producing the clay but in getting it out of Cornwall. Where

very pure products were required the new process must be of very great benefit.

Captain C. J. Goodwin said he noticed in a paper by Dr. Ormandy he referred very extensively to the use made of the osmosis process in Germany. It was no secret that Dr. Ormandy and probably some of his colleagues had again visited the Continent, and it would be of great interest to know to what extent the process had been used during and since the war in Germany and other foreign countries. Apparently the industry was in its infancy in this country. He was anxious to know whether anything had been done to apply the process to the drying of peat. It was a very important question at the present time, because of the great shortage of fuel. In some Continental countries, notably Italy, lignite and peat deposits could be very well utilised if they were amenable to that sort of treatment. In the chemical industry of nearly every country there were certain by-products and factory wastes which were to some extent of a colloidal nature, and those products very often contained material which, if it could be sufficiently recovered, would yield a very handsome profit. One of the commonest instances was perhaps sewage, in connection with which considerable use had been made of centrifugal machines and filters. It would be interesting to know how the osmosis process would compare with other methods that were used, and to have some idea of what the cost of treating the clays was, in order to have a comparative basis in considering the problems. There was also the question of the conditions under which various bodies were capable of undergoing osmosis treatment. The authors had dealt almost entirely with suspensions in water, and he would like to know whether the process was at all applicable to materials suspended in other liquids, such as ferric hydrate in a caustic soda solution or arsenical suspensions in sulphuric acid. He noticed that the clay separated out very rapidly, and he would like to know what the weight of separation was, and whether it varied to any considerable extent with different materials. At the present time considerable interest was being taken in the question of suspension of coal dust and other combustible material in oil, to which the generic name of "colloidal fuel" had been given, and it occurred to him that possibly investigation into the time required for the separation might be a useful method of determining the efficiency of those suspensions in oil.

Dr. W. R. Ormandy, in replying to the discussion, said a very fine piece of work was involved in the coloured photographs which necessitated Mr. Northall-Laurie working very late hours, as even the vibration of passing traffic would ruin the photographs altogether. With reference to the remarks of Sir Herbert Jackson, an osmosed clay muffle, made from a certain clay, lasted thirteen journeys, heated up to 1,500° C., as shown by the pyrometer, whereas muffles made from the same clay used by the muffle maker without treatment would never last three journeys. Taking the finest English china clay which had been treated with 97 tons of water in order to wash 3 tons of clay, it was still possible to separate from that clay 7 per cent. by weight of a product which consisted almost entirely of silica and mica and large rouleaux of china clay, which were not broken up or dispersed by the alkali. Mr. Hancock had rather emphasised the point raised by Sir Herbert Jackson that in the manufacture of optical glass there was a great demand for higher grade refractories than were available previously. That was not only due to the mechanical properties of the clay, but for optical purposes it was essential that the clay substance itself should not enter into the mixture in a pot to any appreciable extent. As most fireclays contained a good deal of iron, iron, which was a colouring matter, was introduced. Therefore, for the optical glass maker, it was essential that he should have a crucible which would stand the high temperature and would not be eaten away by the corrosive action of the products which were being melted. In the manufacture of ordinary commercial glass there was a very great opening for the use of clay treated by the osmosis process, because at the present moment the great glass industries of this country, which were being developed to a degree unknown before the war, were severely handicapped by the kind of clay they had to employ for their tank blocks and for making crucibles. There was no question that an osmosed clay, owing to its refractory properties, would resist the corrosive action of the fluid glass in the tank. In the past manufacturers on the Continent had made great progress in the manufacture of glass, and if this country was to gain the industry to supply not only our own requirements but the world's markets, it would be necessary to recognise that the methods that were used by the Egyptians were still largely in use to-day, and were methods that had to be scrapped. It was no use stating that science was a great thing unless the manufacturer was going to support science and apply it. With regard to Mr. Patchell's remarks, many people had the idea that the straw used in Egypt was mixed into the bricks in the form of a binder, but that was not the case. The Egyptians used to put the straw into tanks and allow it to ferment in a hot climate until it went into a colloidal rotting mass, and that was used to mix with the sandy Nile clay in order to make it more plastic. The lack of demand in this country for purified osmosed china clay in the early days merely showed that the users were not sufficiently educated to realise that it paid to use a scientifically purified product. The manufacturers had to be educated, and to a very large extent the directors of some of the big companies needed education. With regard to Captain Goodwin's remarks, the osmosis process was derived primarily from the Continent, where there had been a greater time to develop it. In

Austria there were already china clay works turning out 60 or 70 tons a day, and there were works at Klingerberg being worked by the process, and very large works with seven or eight machines near Coblenz, and plant was already being erected in Spain. With reference to the drying of peat, that was a subject that had occupied his and his colleague's attention very considerably. The osmose filter press was, in his opinion, the only method which had yet been offered that showed a possible outlet for the treatment on a commercial scale of colloidal peats, which could neither be centrifuged nor pressed. Unfortunately the bulk of peat in the world was of a colloidal type. Such peat could be treated by the osmosis process, and he thought no long time would elapse before Mr. Highfield would be in a position to deal with the matter in another paper. Sewage experiments had also been carried out. One of the troubles was that, whereas clay would travel from one pole definitely to the other, in sewage there was a heterogeneous mass of material, some of which went to one pole and some to another, and some had no electrical property whatever and would not move. As far as his own experiments went, there did not appear to be any immediate prospect of the electrical treatment of sewage proving any solution of the difficulty. As to the conditions of use, it was quite obvious that a particle could not move in an electric field if there was a good deal of soluble salts present, and that ruled out the possibility of separating colloidal ferric hydrate from a caustic soda solution, as the soda would convey the current and a very large amount of electricity would have to be used. The only way in which colloids suspended in an electrolyte could be dealt with would be to use a modification of the process. First of all, the electrolytic salts should be removed from the solution, leaving the colloid in a watery solution, and afterwards it could be dealt with in the same way as clay. With regard to the rate of output, that was conditioned to a certain extent by the electric pressure used, but there was an economical rate which it did not pay to exceed. The figure for all clays seemed to be pretty much the same. The purer the clay the larger the output. Coal dust suspended in oil behaved as a pseudo-colloid and was subject to the same laws as clay suspended in water, but that was a branch of the subject which had only just come into prominence. It would have to come into very much greater prominence, because oil was getting in greater demand every day, and the supply was not growing at more than one-third of the rate of the demand, so that the question of mixing coal dust with oil was a problem of the very greatest importance.

Mr. Highfield said it was quite possible to dry peat economically; with a moderate consumption of electricity the water could be forced out of the peat, and when that was done the peat was in the form of little curled up bits of material like cocoanut shavings. The difficulty was to know what to do with the peat in that form. It could be made into a briquette, but that involved a further consumption of energy, and unless it was made into a briquette it was difficult to carry, because it was bulky, and the cost of freight was high. If a peat was mined on a really large scale, tens of thousands of tons a month, the difficulty would be that, as the peat lies in moderately shallow deposit, it would be always running further away from the plant, as the plant could not be placed upon the yielding beds, so that the cost of bringing the peat to the plant was continually increasing and there were many other difficulties to be overcome apart from drying. He had to thank his colleagues for the enormous amount of work they had done on the paper, and Dr. Ormandy for having answered the questions raised in the discussion. He also wished to thank his assistants, who had been of great help in preparing the experiments.

The Chairman, in proposing a hearty vote of thanks to the authors, was sure the audience would agree that the experiments had been beautifully shown, and that the whole demonstration had been a model of its kind.

The motion was carried and the meeting then terminated.

PETROLEUM IN TRINIDAD.

Considerable attention has lately been attracted to Trinidad in connection with the oil boom throughout the world, and there has been a rapid movement to organise new companies to drill for petroleum in the island. Competition for the purchase of lands thought to be oil-bearing has been keen, and prices have been as high as £100 an acre when indications seemed especially favourable. This applies, of course, only to private lands, as all Crown lands in the mineral-oil districts have long since been leased to British companies.

The island of Trinidad has an area of 1,754 square miles. The petroleum indications are confined to the southern part of the island, and particularly along several more or less clearly defined anticlines, which follow an approximately east to west course. The oil-bearing lands of the island are officially defined in the local regulations, as all lands south of latitude 10° 26′ 36″ N. The oil-beds occur in the tertiary strata, which reach a total estimated thickness of from 6,000 to 7,000 ft., and the productive sources are chiefly confined to two main horizons, which show great persistence over long distances.

The southern anticline of Trinidad, where the beds are steeply inclined, has been traced over the whole length of the southern coast, which it closely follows; the crest only occasionally leaves the land and enters the sea, and never passes far from land. A few miles north of the main southern anticline is a second fairly persistent anticline running also in a direction roughly parallel with the southern, but on this anticline

an oil horizon much higher in the series is brought to the surface. Further north are other anticlines, which can be distinctly traced for long distances in some cases, but they are not so clearly defined as the southern and central anticlines.

On the southern anticline there are many petroliferous strata of apparently no great importance outcropping at intervals, but near the crest, where the main oil zone closely approaches the surface and where the sands of the zone are not too thickly covered with clays, indications of petroleum are to be observed on an extensive scale. At many points where the sands of this horizon lie near the surface, important issues of high-grade petroleum may be observed, saturating the surface sands and soils in the vicinity.

The greatest manifestation of petroleum in Trinidad is the famous Asphalt Lake,* which covers a flat area of approximately 120 acres, about twenty-seven miles south of Port of Spain, the capital, and about half a mile from the Gulf of Paria. Early last year a low-depth record of 150 ft. was obtained with difficulty by boring appliances. The asphalt product of this lake contains the heavy constituents of petroleum oil, and was evidently formed from petroleum which had escaped from oil sands.

Another interesting manifestation of petroleum in Trinidad is manjak, a black, solid, friable bitumen, which has evidently been derived from heavy petroleum traversing fissures in clays, which have caused the abstraction of the lighter constituents, leaving only a solid mass. Also, the issue of hydro-carbon gas is another important indication of petroleum, especially on the Cedros Peninsula at the south-western extremity of the island, where there is a long succession of mud volcanoes nearly always in activity, and in which sometimes violent explosions occur. In 1911, just south of the Cedros Peninsula, a small island suddenly formed, but lasted only about a day, having been caused, it is understood, by subterranean explosion of gas. In addition to such indications of petroleum, there were noticed many years ago in Trinidad practically all the essential conditions for the accumulation of oil, if it existed at all. There were beds of sands of sufficient thickness to store large quantities of oil—sands which exhibited a high degree of saturation where exposed. There were also thick coverings of an impervious clay suitable for the preservation of the oil, and there were anticlines where concentration could take place.

It was not, however, until about the year 1901, that any oil was obtained by boring operations. The pioneers of the Trinidad petroleum industry had to face considerable difficulties. Many of the best localities are clothed in dense jungle, through which there are no roads or waterways. Forests have to be cleared and roads made before any machinery can be conveyed to the sites selected. Another considerable difficulty is the prevalence of fevers; camps have to be specially drained, and houses screened from mosquitoes. Gradually, however, companies were formed, several meeting with fair success.

Up to December 31, 1918, according to the local Inspector of Mines, the total number of wells drilled in the colony amounted to 410, of which 236 are on Crown lands and 174 on private lands. There were 41 new wells drilled during 1918 (37 on Crown and 4 on private lands), and in 29 of these oil was struck. There were 12 companies engaged in producing oil at the end of the year 1918. The production of oil in 1918 showed an increase of nearly 30 per cent. over that of the previous year. The total production of oil in 1918 in Imperial gallons (42 Imperial gallons to one barrel) was 72,872,398, as against 56,080,914 in 1917. In 1918, 54,238 ft. were drilled as against 52,037 ft. in 1917. The production of oil on Crown lands in 1918 was just about double the production of oil on private lands. Out of the total production in 1918 of 72,872,398 Imperial gallons, there were 27,920,015 Imperial gallons taken by ships for bunker purposes, 12,936,283 Imperial gallons exported, and the balance of 32,016,100 Imperial gallons used for local consumption. The oil exported was crude petroleum, which was sold to the Admiralty.

According to a report by the United States Consul in Trinidad, at the beginning of 1919 there were twelve companies engaged in producing oil in the island, but only those with considerable capital or financial backing have thus far met with any real success, notwithstanding that it is comparatively easy to find some oil on the anticlines without particularly deep boring; practically all the oil thus far produced coming from shallow sands less than 2,000 ft. deep. The difficulty with production, in the case of every company operating, is, that while wells produce encouragingly at first, the production tends to fall off quickly, and good gushers often become choked by sand very soon. The anticlines are steep, and the pools usually narrow, so that the wells are not very large.

Apparently the best pool in Trinidad is that at Fyzabad, and the success in this district has caused considerable speculation in adjacent lands, and the organisation of new companies to commence operations. About 15,000 barrels of petroleum have recently been produced from three wells adjoining the Fyzabad field. The heaviest oil in the southern fields, including Fyzabad and Brighton, is about 12° Baumé. The best oil from Trinidad runs as high as 45° to 46° Baumé, and will produce 35 to 40 per cent. motor spirit and the same percentage of kerosene. The petroleum from this field is understood to be unsurpassed in quality by any oils found anywhere in the world, but its production up to the present has been comparatively limited.

The principal reasons why Trinidad attracts much attention as a field of possible profitable and continuous development of petroleum industry are: First, the favourable indications of petroleum extending over long distances where there are

* Particulars of this Lake appeared in the *Journal* of 2nd January last, page 109.

unusually extensive displays of natural phenomena, such as are often associated with important oil fields; second, the favourable, though not necessarily ideal, structure which in many cases characterises the strata amidst which the oil sands are distributed; third, the satisfactory yields often obtained from shallow wells drilled at widely separated localities; fourth, the proximity of most of the promising oil districts to the sea; and, fifth, Trinidad's exceptional geographical position with regard to the markets of the world, especially with reference to important routes of commerce. A large number of vessels now equipped to use fuel oil instead of coal find it very convenient to stop at Trinidad to secure oil for bunker purposes. This is especially true of vessels in trade between North and South America, and of those passing through the Panama Canal. Between such ports as Buenos Aires or Rio de Janeiro and New York, it is often extremely convenient for vessels to stop at Trinidad to replenish bunkers with oil, and sometimes continuation of voyages would hardly be possible without calling there to replenish bunkers.

There is also a good local market in the West Indies for petroleum products. In Trinidad itself, fuel oil has now almost entirely supplanted coal for all industrial purposes, owing to its cheapness, its higher calorific efficiency per ton, and its convenience in handling.

The Trinidad Government Railway has lately been equipping its locomotives with oil burners, so that fuel oil can be used instead of coal; and the local Gulf steamers now use oil instead of coal. The municipalities of Port of Spain and San Fernando utilise fuel oil for operating their waterworks; moreover, in Port of Spain, fuel oil is used for operating the tramway system and the electric-lighting plant. Considerable use, also, is made of crude oil on pavements for disinfecting purposes, and, in the campaign against malaria, for preventing stagnant pools of water becoming breeding places for mosquitoes. There is also considerable use of kerosene for lighting purposes.

Although Trinidad as an oil-producing country has advantages as above explained, nevertheless the industry, up to the present time, can hardly be considered to have yielded very favourable financial results—at least as compared with the best-known developments in the United States, Mexico, and other important petroleum-producing countries. The heavy gas pressures and soft shifting formations in Trinidad have proved serious obstacles to economic development, and constant disappointments are experienced by wells gushing most violently at first, and to such an extent that but little of the oil can be saved, and then, perhaps, in a few hours becoming so clogged by rocks and sand that production stops almost as suddenly as it began. The average life of good producing wells is apt to be very short, so that constant investment of new capital is necessary to keep up any large aggregate of production, and constant extension of drilling operations is necessary in order to reap the benefit of heavy outlays upon pipe lines, storage accommodations, shipping facilities, and other works of a permanent character. It seems probable that more scientific attention to the peculiar conditions of Trinidad, as regards its strata levels of soft rocks, shales, sandstones, and clay, with improved methods of drilling to take into account such conditions, would result in more substantial success in producing large quantities of oil and maintaining longer periods of production of wells striking oil.

The most interesting possibilities of the future, as regards the oil industry in Trinidad, might be in drilling wells of far greater depths than have as yet been attempted. In the field of operations of one important company, the policy at present is to deepen existing wells, instead of drilling new ones, and the results thus far seem quite promising; not only more oil, but oil with a world record in quality, has been found at lower depths. But, as yet, there has been no drilling lower than 3,000 ft. The difficulty, which has for some time existed, of securing sufficient supplies of well casing and pipes, has considerably retarded many important operations. Some of the leading geological experts who have visited Trinidad are of the opinion that if drilling operations should ever be conducted considerably below the comparatively shallow depths thus far reached (as has been done in other countries, where great success has been attained), almost unlimited supplies of oil might be found, and the local industry placed on a far more substantial basis than at present.

OBITUARY.

Sir Alexander Baird, Bt.—Information has been received of the death at Cairo of Sir Alexander Baird, who had been a member of the Royal Society of Arts since 1897. He was born in 1849, and was educated at Harrow. In 1879 he was sent to Upper Egypt to engage in famine relief work in the provinces of Girgeh, Kenneh, and Esneh. He was created a baronet in 1897, and was Lord Lieutenant of Kincardineshire since 1889.

NOTES ON BOOKS.

Pyrometry. By Charles R. Darling. Second edition, revised and enlarged. London: E. & F. N. Spon, Ltd. 10*s.* 6*d.* net.

The first edition of this book appeared in 1911. It was founded on the course of Cantor Lectures on "Industrial Pyrometry" delivered by the author before the Society in 1910, and the resultant volume was the first attempt—and a very successful one—to gather together in a handy form the information required by those who make actual daily use of pyrometers.

A great deal of progress has been made in the science and art of pyrometry during the war. New appliances have been introduced and old ones improved. Probably no one has taken a more

active part in this development than the author himself. There are now a great many different kinds of pyrometers in the field, each of which is specially suitable for its own purpose. They are discussed here under the following heads: thermo-electric, resistance, radiation, optical, calorimetric and fusion pyrometers. A chapter on miscellaneous appliances completes an excellent hand-book.

Mr. Darling is well known to Fellows of the Society as an admirably clear lecturer. He is an equally clear writer, and his accounts of the various instruments are models of lucid description.

BLACKIE'S COMPACT ETYMOLOGICAL DICTIONARY. Prepared by Richard John Cunliffe, M.A., LL.B. London, Glasgow, and Bombay: Blackie & Son, Ltd. 2*s*. net.

In these days of inflated prices it is satisfactory to come across a sound, compact etymological dictionary of 380 pages that can be purchased for two shillings. It is based on the highest authorities, and, so far as we have been able to test it, the work has been carried out in a sound and scientific manner throughout. The need to keep the book within small limits, has, of course, made it impossible to include anything like the whole of the current English vocabulary; but the compiler seems to have justified his claim that he has included all words likely to be met with in reading modern works that can be regarded as literature.

A novel feature of this dictionary is an Appendix of terms of special note in modern warfare. The majority of these are legitimate words or phrases, and it is useful to be able to ascertain their precise meaning; but one may perhaps doubt the wisdom of including in a dictionary of this limited size such slang as "Aussies," "Civies," "wangle," and "wash-out."

GENERAL NOTES.

BRITISH MOTOR CYCLE INDUSTRY RESEARCH ASSOCIATION.—The Research Association for the British Motor Cycle and Cycle Car Industry has been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. As the Association is to be registered as a non-profit sharing company the promoters have applied to the Board of Trade for the issue of a license under Section 20 of the Companies' (Consolidation) Act of 1908. The Secretary of the Committee engaged in the establishment of this Association is Major H. R. Watling, "The Towers," Warwick Road, Coventry.

ROME SCHOLARSHIPS, 1921.—Particulars are published of the Competitions for the Rome Scholarships in Architecture, Decorative Painting, and Sculpture, offered by the Commissioners for the Exhibition of 1851, for the Rome Scholarship in Engraving, offered by the British School at Rome, and for the Henry Jarvis Studentship, offered by the Royal Institute of British Architects. In each case the offer is of the value of £250 per annum, ordinarily tenable at the British School at Rome for three years. Candidates must be British subjects, and under 30 years of age on July 1st, 1921. The competitions will be in two stages: (1) an open examination, and (2) a final competition open to not more than four candidates selected from those competing in the open examination. Details of the competitions may be obtained from the Hon. General Secretary, Office of the British School at Rome, 1, Lowther Gardens, S.W. 7.

POPULATION OF THE PANAMA CANAL ZONE.—According to a census of the Canal Zone taken by the Police and Fire Division in August, 1919, the total civil population is 21,759, of whom 7,031 are Americans and 14,728 of other nationalities. There are 10,517 men, 4,814 women, and 6,428 children. A year ago the total civil population of the Zone was 21,707, and two years ago it was 23,295. The total number of Government employees is 9,698, of whom 3,317 are Americans and 6,381 of other nationalities.

WOOD FOR BUTTER BOXES.—New Zealand in the past has imported annually over 4,000,000 feet of white pine for butter boxes. Owing to the depletion of its forests, dairymen have become somewhat concerned over the possibility of a shortage of timber, and attempts are being made to discover timber suitable for the butter trade. It is claimed that if mountain ash is properly seasoned and treated it will prove as satisfactory as white pine, and a number of interesting experiments have been made along this line.

MEETINGS FOR THE ENSUING WEEK.

TUESDAY, JUNE 29...Wireless Society of London, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m.

Anthropological Institute, 50, Great Russell-street, W.C., 3 p.m. Sir C. Hercules Read and Messrs. T. Allworthy, V. B. Crowther-Benyon, S. Fenton, G. W. Willis, and others, "Exhibition of Bronze Age Implements."

Horticultural Society, Vincent-square, Westminster, S.W., 3 p.m. Mr. H. R. Darlington, "Garden Roses."

WEDNESDAY, JUNE 30...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 4 p.m. Annual General Meeting.

University of London, at the School of Oriental Studies, Finsbury-circus, E.C., 5 p.m. Professor A. J. Toynbee, "The Middle East." Lecture V.—"Dark Age and European Ascendancy (11th to 20th century A.D.)."

Electrical Engineers, Institution of, at the Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W., 6 p.m. Sir Philip Dawson, "Electric Railway Contact Systems."

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FRIDAY, JULY 2, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

PROCEEDINGS OF THE SOCIETY.

ANNUAL GENERAL MEETING.

The One Hundred and Sixty-sixth Annual General Meeting for receiving the Report of the Council, and the Treasurers' Statement of Receipts and Payments during the past year, and also for the Election of Officers and New Fellows, was held in accordance with the By-laws on Wednesday last, June 30th, at 4 p.m., Sir Henry Trueman Wood, Chairman of the Council, in the chair.

The Secretary read the notice convening the meeting, and the Minutes of the last Annual Meeting and of the General Meeting held on August 11th, 1919.

The following candidates were proposed, balloted for, and duly elected Fellows of the Society:—

Baines, Sir Frank, C.B.E., M.V.O., London.
Baines, Hubert, C.B.E., London.
Blakemore, Frederick William, A.C.I.S., Timperley, near Manchester.
Booth, Frederick Augustus, Harborne, Birmingham.
Boys, Captain Henry Cecil, M.B.E., London.
Burrow, Edward John, Cheltenham.
Button, Norman, London.
Cherry, John Arnold, C.I.E., Bombay, India.
Freeland, Major-General Sir Henry, K.C.I.E., C.B., D.S.O., M.V.O., Bombay, India.
Gill, John Hamblet, London.
Goodwin, Engineer Vice-Admiral Sir George Goodwin, R.N., K.C.B., Sutton, Surrey.
Green, L. B., M.B.E., Madras, India.
Gupta, N., C.I.E., Calcutta, India.
Haggar, James Joseph Percival, Flixton, Lancashire.
Hakes, James A., Sunbury-on-Thames.
Halsall, Charles Frederick, M.I.A.E., London.
Hartigan, Lieut.-Colonel Marcus Michael, C.M.G., D.S.O., Ashford, Middlesex.
Hegarty, R. D., London.
Holmes, Henry Cresswell, Gosforth, Newcastle-on-Tyne.
Hosken, Richard, Assoc.M.Inst.C.E., M.I.M.E., London.
Jonason, Otto Axel Ragnar, Hull.
Kent, T. O., East Molesey, Surrey.
Locke, Miss M. Katherine, Youngstown, Ohio, U.S.A.
Long, Burt, Horley, Surrey.
Mehta, Jehangir K. B., Bombay, India.
Miller, Frank, Beckenham, Kent.
Nicholson, John Hatfield, Radlett, Herts.
Osborne, F. B., London.
Peters, Thomas, Sydney, New South Wales, Australia.
Phillips, Randolph Warrington, London.
Pike, Clement Allin, London.
Preater, Charles John, M.Inst.Met., Bath.
Preston, W. E., London.
Rose, Lieut. L. W., Jerusalem, Palestine.
Rowlands, Joseph, J.P., Malvern.
Rutherford, Henry, London.
Sarasasna, Lieut.-Colonel Bra, Bangkok, Siam.
Shalders, John Frederic, Rio de Janeiro, Brazil, South America.
Smith, George, London.
Sprott, Ernest W., London.
Stuart, John Matthew Blackwood, B.A., Enniskillen, Ireland.
Sutherland, David Alexander, A.C.I.S., Edinburgh.
Sykes, W., Chicago, Illinois, U.S.A.
Tarrant, Ernest Frederick, London.
Timbrell, W. H., Foochow, Fukien, China.
Tullis, John, B.Sc., London.
Walker, E. M., Terre Haute, Indiana, U.S.A.
Williams, C. Harold, Llanelly.

Honorary Corresponding Fellow:—

Vegas, Santiago, Caracas, Venezuela.

The Chairman appointed Mr. Frank Cundall and Mr. Henry Hill scrutineers, and declared the ballot open.

The Secretary then read the following—

REPORT OF COUNCIL.

I.—Introduction.

At the close of the Society's 166th Session, the Council are glad to be able to congratulate the Fellows on a year's work, which in all respects but one—finance—has been entirely successful. The number of Fellows elected since last June is again a record, being 479, as compared with 455 in 1918-19, the previous highest figure. The entries for the Society's

Examinations also constitute a record, the number this year being 54,010, as compared with 37,973 in 1914, the previous highest figure. In spite of these facts, however, the question of finance has caused the Council grave anxiety. Although the income from subscriptions rose from £5,780 in 1918 to £6,261 in 1919, the costs of printing, paper, and general maintenance charges have increased in still greater proportion, and the Council have reluctantly come to the conclusion that it is no longer possible to carry on the work of the Society at the present subscription of £2 2*s.*—a sum which has remained unaltered since 1754, when the purchasing power of money was hardly comparable with its purchasing power to-day. Accordingly, with the unanimous support of the Council, the Chairman has undertaken to move, at the Annual General Meeting, that the annual subscription be increased to £3 3*s.*

II.—Ordinary Meetings.

Sir Henry Trueman Wood, Chairman of the Council, selected as the subject of his opening address, "Science and Industry." He sketched the industrial history of this country during the last century, and showed that the Society had played an effective part in the development of inventions and industries. After a brilliant review of the past, he turned to some of the problems of the present and future, such as the steps taken by the Government to promote scientific and industrial research, and the provision of new sources of power.

Dr. H. B. Morse outlined the history of British trade in China from 1637, when the first English ship arrived in Canton, to the present day. In the course of his paper he gave some striking statistics illustrating the growth and decline of this trade. In 1833, 58·1 per cent. of Chinese exports went to the United Kingdom; in 1867 this percentage had risen to 66·6; while in 1905 it fell to 7·0. Similarly, English percentages of the total imports into China were:—in 1833, 10·5; in 1867, 41·3; and in 1905, 23·5. The principal causes for the decline in the percentages in recent years are threefold: (1) The United Kingdom no longer buys tea in great quantities from China, but takes it principally from her own empire—India and Ceylon; (2) We have not taken our proper share in developing the new export trade of China; oil seeds go to Japan, France and (before the war) to Germany; fibres mainly to Germany, and so forth; while (3) silk, of which London used to be the Western world's market, goes largely to Lyons and Milan. Dr. Morse concluded by giving some suggestions which might lead to the improvement of our position with respect to Chinese trade, the principal of which were the prompt publication of commercial information by the British Government, the encouraging of Chinese students to come to this country for education, and the discovery of the best method of advertising British goods in China.

The seed-crushing industry has made enormous strides during recent years, and probably no one has contributed more to its development than Mr. J. W. Pearson, who read a paper on the subject at the third Ordinary Meeting. After dealing with the materials, the greater portion of which are produced within the British Empire, mainly in the Torrid Zone, Mr. Pearson described the principal kinds of manufacturing plant which perform the operations of cleaning, rolling, cooking, pressing and paring. He also referred to the chemical process of extracting oil, a process in much more general use in Northern Europe than in this country. The final portion of the paper was devoted to the products, which are very numerous and varied, and it is in this connection that the most interesting developments have taken place in recent years. There is an enormous and rapidly-growing demand for vegetable oils of all descriptions—the home output of margarine alone has risen from 2,000 tons per week before the war, to 10,000 tons per week to-day—and modern invention is directed to securing the utmost utilisation of the raw materials, and the elimination of waste at every stage. Reference was made to the hydrogenating process, in which pre-neutralised oil is exposed to a stream of heated hydrogen gas in the presence of a catalyst. Mr. Pearson described this as "probably the most interesting process of recent date." The action of the catalyst is not yet completely understood, but the results are remarkable. Liquid oils can be converted into hard oils at a cost of about £5 a ton, and as hard oils have always commanded a premium of from £10 to £15 a ton over liquid oils, it will be seen that a great future lies before this process.

Sir Oliver Lodge's Trueman Wood Lecture was in every way a worthy successor to the two brilliant lectures delivered by Sir Dugald Clerk and by Sir Herbert Jackson. He selected as his subject, "Sources of Power, Known and Unknown." In the first part he dealt briefly with coal, water, the sun, the internal heat of the earth, and the tides as sources of energy; the second part he devoted to consideration of

the energy of the atom. The subject is full of most intricate difficulties, and our study of it only dates back some twenty years; but Sir Oliver contrived to place before his audience a vivid presentment of the atomic world, and suggested possibilities of practical developments that have as yet been hardly dreamt of by engineers.

At a time when it was difficult to obtain any information as to the true condition of Russia, except such as was to be found in the more or less sensational articles in the Press, the Council welcomed a sane and well-informed statement from Mr. Constantine Grunwald, who was formerly Chief of the Intelligence Department of the Russian Ministry of Trade, and is now General Secretary to the Russian Manufacturers' and Merchants' Association in London. In spite of the terrible conditions brought about by Bolshevism, there are circumstances which make the plight of Russia far from hopeless. The natural resources of the country are boundless, and, given improved means of transport, these could be rapidly developed. The Russian Consul-General, who spoke in the discussion, went so far as to say that after the first good post-war harvest Russia would be rich again. The first thing to aim at is political peace and security. Mr. Grunwald appealed to this country to assist Russia in reconstructing herself, and not to allow Germany to secure full control of Russian resources in raw materials.

Mr. Alfred H. Powell, in his paper on "Ancient Cottages and Modern Requirements," made a double plea for the preservation of ancient cottages on the ground of their artistic beauty, and because they can in many cases be placed in good habitable repair at less than the cost of a new cottage. He gave some general directions as to the lines to be adopted in making an old cottage fit for use without destroying the qualities which it owes to age. No old cottage need be pulled down so long as its outer shell is still in fair condition. The Secretary of the Society for the Protection of Ancient Buildings, who spoke in the discussion, stated that his Society was anxious to purchase an old cottage and restore it on approved lines, and then issue an illustrated pamphlet showing the various stages in the process, which would be distributed throughout the country as a guide to district councils. It is satisfactory to note that, as a result of the meeting, a gentleman promised the sum of £500, which it was estimated would be sufficient for the purpose in view.

Sir Cecil Hertslet, who lived in Antwerp for fifteen years as British Consul-General, read an able and eloquent paper on "The Ruin and Restoration of Belgium." He gave some striking illustrations of the systematic ruin worked by the Germans in the Belgian factories with the avowed object of endeavouring to prevent Belgium from competing with Germany as an industrial country for many years to come. It is to be hoped, however, that this diabolical purpose will be frustrated. The Belgian workmen, after years of idleness forced upon them under the German occupation of their country, are tired of doing nothing and eager to work. The port of Antwerp, which was becoming a grass-grown wilderness, is rapidly returning to its pre-war activities; the blast furnaces, which were re-reduced from fifty-four to one, have already increased again to eleven; while the number of cotton spindles produced in November last was 1,200,000, as compared with an average of 1,700,000 in pre-war days.

In his paper on "The English Language and International Trade," Mr. Alfred E Hayes gave an interesting account of the work which he had carried out on the invitation of the Danish Government to conduct in Denmark summer courses in English for Danish teachers. The courses were attended by students who were eager to learn not only the English language, but English ways of thought, and to study English books, and Mr. Hayes's ideal is to establish similar organisations in all foreign countries. Before the war the German Government spent large sums of money in familiarising other nations with the German language or German thought. The British Government has hitherto spent little or nothing in this direction, although it is obvious that this country can only derive benefits from such activities—benefits to which it is impossible to set limits. In the first place they would probably lead to large sales of British books abroad, to a fuller understanding of British life and methods, and, by encouraging friendly feelings between Britain and other nations, to an expansion of her trade with them.

Lieut.-Commander Norman Wilkinson made clear—what must have been a puzzle to many people—the principles on which the Admiralty acted in camouflaging ships. The extraordinary effects with which one became familiar during the last two years of the war, were obviously not devised to secure invisibility. Lieut.-Commander Wilkinson showed in his paper that, owing to continual changes of colour of sky and sea, such invisibility would always be quite unobtain-

able: if you painted a ship to be invisible against a dark sky and sea, it would stand out clearly defined on a bright sunny day. The object aimed at was quite other than this: it was so to break up the outline of a ship that the commander of an attacking submarine would be baffled and unable to decide exactly what course she was steering, and so hesitate as to what position he should take up in order to attack with success. That the results—which were largely due to the invention of Lieut.-Commander Wilkinson—were extraordinarily confusing it is impossible to doubt; and though there are, of course, no means of estimating how many ships were saved by "dazzle painting," the highest authorities are agreed that they were very numerous.

Among many problems whose importance has been emphasized by the war and by the subsequent increase of prices, not the least vital is the question of transport. Two papers on very different aspects of it were read during the session: the first, by Mr. Sidney Preston, on "English Canals and Inland Waterways," the second, by Air-Commodore Edward Maitland, on "The Commercial Future of Airships." English canals to-day are very much as they were when they were first constructed: for various causes they have been left *in statu quo* while other means of locomotion have been developed. If they have become out of date, then, is there much cause for wonder? As Mr. Preston remarked, "Could one imagine what would be the present state of motor traffic if the roads of England were in the same condition as they were before Macadam lived, and if they had been dependent for development and improvement on the Turnpike tolls?" Yet it seems obvious that for certain classes of traffic—heavy goods for the delivery of which there is no immediate hurry—the barge is excellently suited. During the war the canals were, of course, taken over by the Government, and were under the Canal Control Committee, of which Mr. Preston became Chairman. The problem as to what is to be done with the canals now is awaiting solution by the Ministry of Transport. It is an exceedingly difficult one, involving financial considerations of the most complicated kind. A survey of the whole situation was given in the paper.

If there has been no progress in the development of canal traffic for a century, the airship as a commercial vehicle is improving day by day. Up till now it has only been used for military purposes in this country, but in Germany considerable attention has been paid to its commercial possibilities. Air-Commodore Maitland went into considerable detail in estimating the cost of airships, bases, maintenance, depreciation, salaries of crews, etc., and arrived at the conclusion that the present "all-in" cost per ton-mile would be about 2*s.* 9*d.*, though he expressed the hope that, making reasonable allowance for operational improvements, this figure might soon be reduced to 1*s.* 9*d.* The saving of time is, of course, very great. Thus Egypt could be reached in two days, India in four and a half days, South Africa in six days, and Australia in nine and a half days. With our rapidly increasing knowledge of meteorology it seems fair to hope that regular services might be maintained. There is one other aspect of the question which deserves to be borne in mind. A commercial airship can be turned into a military airship as easily as a merchant vessel of the Elizabethan day could be turned into a fighting ship, and in any war of the future the military airship must play an important part, while the crews that run the airship in time of peace will provide the skilled hands to man it in time of war.

The necessity of creating in the shortest possible time a large amount of skilled labour for the production of munitions led to the establishment of the Training Department of the Ministry of Labour. The work of this Department was described by Mr. (now Sir) James Currie, who has been for some time responsible for its conduct. The nature of the problem which he had to deal with has undergone a gradual change: at first the main object of the Department was to secure the output of munitions, and with this end in view large numbers of women had to be rapidly trained; now the main object is to train men—many of them disabled soldiers—in engineering and other industrial trades. It is estimated that the number of disabled men who will require training facilities is not far short of 80,000, so that the problem is a formidable one. Mr. Currie outlined the schemes which he divided into (1) training in technical schools; (2) training in instructional factories; and (3) training in instructional bays attached to factories.

Comparatively little is known of the vast area called Mongolia. It has attracted few travellers, probably because the methods of transport are of the most primitive kind, and large parts of the country are bare and inhospitable. In a paper called "Mongolia from the Commercial Point of View," Mr. William James Garnett described a seven months' journey which

he made there in 1908, mostly on camel back. While he thinks it will be a long time before the Mongols can be consumers to any considerable extent, he believes that the resources of the country are quite unknown, and that it could support a much larger population and more stock than it at present holds. In the days of the great Khans, Mongolia appears to have been a very much wealthier and more prosperous country than it is now. Mr. Garnett thinks it might be restored to that position, but the problem is, who will develop its resources? The Mongols are evidently incapable of doing so. Possibly the Chinese may undertake the task.

Mr. H. M. Thornton had already read before the Society two papers on the uses of coal gas in industry. During the war great advances were made in this direction, and in his paper, "Gas in relation to Increased Output and National Economy," he summarised the results of this development. The subject was dealt with under four heads: (1) The eliminating of waste; (2) the cheapening of production; (3) the speeding-up of output; and (4) the human element, or improvement of working conditions. Owing to the fact that it is possible to regulate the heat of gas-fired furnaces with great precision, there is little danger of wasting material in consequence of subjecting it to too high or too low temperatures, and by using gas it is also possible to save all the valuable by-products of coal. A double economy was claimed for the gas furnace, as compared with the coke furnace: not only is the value of the gas consumed less than that of the coke consumed, but the amount of labour required to attend to gas furnaces is also considerably less than that required for coke furnaces. Further, the gas furnace is cleaner and more easily handled, and evidence from several works was quoted by Mr. Thornton showing that in cases where gas furnaces had been introduced, even though at first the men were disposed to resent them, they had soon become their warm partisans.

Mr. W. Worby Beaumont's paper on "Street Passenger Transport in London" resolved itself into a discussion on the relative merits of motor omnibuses and tramcars. The tramcar suffers from obvious disabilities: it cannot leave the lines on which it runs, and in the event of a breakdown all the cars on the line affected may be held up. The motor omnibus, on the other hand, is comparatively handy; it can thread its way through traffic and is an independent unit. Moreover, it has no need of tram-lines, which are injurious to the tyres of other vehicles. Mr. Worby Beaumont also claimed that the tramcar as it exists to-day is unduly expensive, both in its construction and in the amount of horse-power necessary to enable it to run at high speed while frequently stopping. The paper was followed by a keen discussion, in which the champions of the tramcar maintained that in the present conditions of London traffic, when there are enormous rushes in the mornings and the evenings, the tramcar is an absolute necessity that cannot be dispensed with.

In a paper, of which it was only found possible to publish a *résumé* in the *Journal*, Mr. Joseph Thorp defined the basic principles of good printing. Adopting as his criterion "fitness for purpose," he insisted on legibility as the first necessity. His next point was the proportions of the page, the relative widths of margins, etc., which are very important in determining whether a book is attractive to read or not. The ideal lengths of the line were considered in relation to the size of the type, and finally the question of ornament was discussed. This needs the most careful restraint, and, unless treated with the soundest judgment, interferes at once with the legibility of the print and with its really artistic appearance.

Dr. C. E. Kenneth Mees gave an exceedingly interesting account of the Kodak Research Laboratory at Rochester, New York State, where he has been working for the last eight years. He described in some detail the building itself, the largest of its kind in the world, and then proceeded to give an account of the kind of work conducted there in connection with the physical, chemical and practical aspects of photography. He showed the methods by which the study of sensitive materials is conducted, and exhibited a number of slides illustrating the microscopic structure of silver bromide grains, etc.

Mr. Leon Gaster, who has already read papers and delivered a course of Cantor Lectures before the Society on various aspects of illumination, dealt with the question of Industrial Lighting and its Relation to Efficiency. There is no doubt that a large number of industrial accidents are due to inefficient lighting: Mr. Gaster quoted statistics of American experiments which demonstrated this beyond a doubt; and it follows therefore that the prevention of accidents due to this cause is amply justified on economic grounds alone, to say nothing of the humanitarian side of the argument. The increase of output which attends improved illumination is equally marked, and is out of all proportion

to the increase of cost which such improvement involves. Roughly, the lighting of a factory costs only 1 per cent. of the wages bill, so that the expense of any desirable improvement of lighting is comparatively negligible. The vital importance of good illumination as regards safety, health, and efficiency of work is now so generally recognised that in Mr. Gaster's opinion the time has come when definite requirements as to lighting should be inserted in the Factory Act, as is already done in the case of heating and ventilation.

Brigadier-General Charles H. Sherrill has made a life-long study of stained glass, and has written two excellent works on the subject—"Stained Glass Tours in France," and "Stained Glass Tours in England." In the paper which he read in April last he gave a charming account of the principal stained glass in England and France. Beginning with some twelfth and thirteenth century examples of the *peintres-verriers'* art in France, he showed a very large number of slides which included almost all the best-known windows in the two countries. The slides were made by the autochrome process of photography, and gave an excellent idea of the beauties of the originals.

At a time when the country is being flooded with war memorials of all descriptions, a paper by Mr. Graily Hewitt on Rolls of Honour was opportune. The author is generally recognised as one of the finest penmen living, and he has done as much as anyone to improve the style of British lettering. He dealt not only with the form of the inscriptions, but also with the various materials—stone, brass, copper, parchment, etc., —on which they may be written, and he further gave some excellent advice as to the way in which they should be worded. Unfortunately, many of the examples which one sees contain all the worst faults that he condemned. It is to be hoped that his paper, which was much appreciated by his audience, will have some effect in improving both the style and the matter of those rolls of honour which are still to be carried out.

The paper read at the last ordinary meeting of the Session, on "The Commercial Application of Electrical Osmosis," by Mr. J. S. Highfield, Dr. W. R. Ormandy, and Mr. D. Northall-Laurie, was one of very great interest and importance. Electrical osmosis is a process that may be applied to a great many materials. For the purposes of this paper the authors dealt mainly with its application to clays, and the process was illustrated with a number of striking experiments and some very beautiful lantern slides. Stated briefly, the process is as follows:—"If in the prepared suspension [*e.g.*, liquid clay] two electrodes are immersed, and a difference of electrical potential be established between them, the clay particles move to the anode, where they discharge themselves and adhere as a coagulated mass, and the water is driven to the cathode, leaving the clay in a semi-dry state attached to the anode." A demonstration was given in which a quantity of china clay was reduced to a condition of great purity in a very short time; and, in the discussion which followed the paper, evidence was given that crucibles made of osmosed clay were vastly superior in length of life and other qualities to crucibles made of materials treated in the ordinary way.

III.—Indian and Colonial Sections.

The Indian Section held seven successful meetings, and the Colonial Section three. There was also, for the first time, a joint meeting of the two sections.

The Indian papers, taking them in chronological order, were:—(1) "Some Problems of Indian Education," by Mr. P. J. Hartog, member of the Calcutta University Commission; (2) "Burmese Village Industries," by Mr. A. P. Morris, Art Officer to the Government of Burma; (3) "The Indian Currency System," by Sir William Meyer; (4) "The Ports of India," by Sir George Buchanan, well known in connection with large engineering undertakings in the East; (5) "Roads and Motor Transport in India," by Brig.-Gen. Lord Montagu of Beaulieu, for five years, 1915–1919, Adviser on Mechanical Transport Services in India; and (6) "The Improvement of Crop Production in India," by Mr. A. Howard, the distinguished Imperial Economic Botanist to the Government of India. At the seventh Indian meeting, the first annual Sir George Birdwood Memorial Lecture was delivered by Sir Valentine Chirol.

Mr. Hartog dealt principally with the educational problems of the great province with which he is best acquainted—Bengal; but he also touched on their bearings on the peninsula as a whole. Not the least suggestive of the topics embraced in a singularly comprehensive and lucid survey was: How far will Europeans continue to play a part in Indian education? Mr. Morris set out to show that the encouragement of some Burmese handicrafts is desirable, that in certain cases the causes which have weakened domestic industries might be removed, and that others have already been improved by

aid which is not "mere benevolent bolstering." Sir William Meyer abstained from all "polemical preachings," his masterly paper being mainly an historical account of the Indian currency system, and the ways in which it has been developed to meet the stress of very varying circumstances. Sir George Buchanan argued that unless there is a change in the method of administering and developing Indian ports it will be impossible for them to keep pace with the requirements of an increasing trade. He recommended the creation of a Department of Communications, and the Secretary of State for India, Mr. E. S. Montagu, M.P., who occupied the chair, announced that such a scheme is now under consideration. Lord Montagu of Beaulieu made proposals for the improvement of Indian roads, including the establishment of a Road Department. He pointed out the need for types of transport vehicles specially designed for tropical use. Mr. Howard, besides exhaustively dealing with the lines of advance in crop production through the plant, indicated the wide range of the agricultural problems in a country whose greatest industry is, and must for a long time be, agriculture. Sir Valentine Chirol in selecting the subject of his brilliant lecture, "The Enduring Power of Hinduism," was chiefly moved by the desire to find one with which Sir George Birdwood would have been in full sympathy.

The papers read before the Colonial Section were: "Problems of the West Indies," by Sir Edward Davson; "Tropical Departments of Agriculture," by Sir Francis Watts; and "Trade Routes for the British Empire in Africa," by Mr. G. F. Scott Elliot. Federation of our oldest group of colonies and labour difficulties were amongst the many points treated by Sir Edward Davson in his able paper. He cordially supported the proposal to provide the West Indies with a College of Tropical Agriculture, the urgent need for which was also emphasised later by its most prominent advocate, Sir Francis Watts. The purpose of Mr. Scott Elliot's interesting paper was to make the general public realise our present opportunities in Africa, and to enforce the necessity for the adoption of a carefully-planned scheme of development in the most backward of all the Continents.

The enormously important question treated at the joint meeting, the Empire's oil resources, was in the very capable hands of Sir John Cadman. The value, at this moment, of his paper, and of the remarks made in the discussion by Mr. E. G. Pretyman, M.P., late Civil Lord of the Admiralty, "probably the first to see with a statesman's clear vision the coming of the Oil Age, and the need for an Empire oil policy," as Sir John Cadman observed, by Sir Marcus Samuel and by others, can hardly be overestimated.

IV.—Cantor Lectures.

The first course of Cantor Lectures, delivered by Dr. John Theodore Hewitt, dealt with the subject "Synthetic Drugs." The lecturer explained the chemical action in the manufacture of the simple aliphatic compounds; ketones and their derivatives, such as sulphonal; veronal; the non-aromatic cyclic compounds; phenol; salicylic acid; derivatives of the aromatic amines and amino phenols; compounds of heterocyclic structure, such as antipyrine, flavine, etc.; modified alkaloids; and the organic compounds of arsenic, antimony, mercury, and other metals.

Captain H. Hamshaw Thomas, who delivered the second course, chose as his subject "Aircraft Photography in War and Peace." He described the great strides which had been made during the war in the taking of aerial photographs and the development of the aerial camera. He then discussed the value of aerial photographs in war, the types of intelligence which they furnished, the kind of training necessary in order to learn how to interpret them intelligently and correctly, and the effects which air photography would have in modifying strategy. In his last lecture he turned to the uses of aerial photography in times of peace, showing how it might be employed in compiling or improving maps, and generally applied in exploration and survey work.

Mr. C. F. Cross gave the third course on "Recent Research in Cellulose Industry." The subject covers a great variety of problems, many of which are of great importance to large industries. Jute, esparto and other wood fibres used in paper manufacture, cotton, twisted paper yarns, cotton and artificial silk, were all discussed by the lecturer, who gave an account of the latest researches in these matters and suggested possibilities of further developments.

The fourth course, on "Aluminium and its Alloys," was delivered by Dr. Walter Rosenhain. A great deal of work has been carried out during the war in investigating the properties of these alloys—much of it under the supervision of the lecturer at the National Physical Laboratory—and the results were summarized in this course.

The properties of various alloys—with copper, with zinc, with zinc and copper, and with more complex ingredients—were described; their composition, microstructure and physical properties were illustrated, and the various objects for which they were specially suitable were fully dealt with.

The fifth and final course was delivered by Mr. Arthur Thomas Bolton on "The Decoration and Architecture of Robert Adam and Sir John Sloane, 1758–1837." The general position of English architecture at the time of Robert Adam's return from Italy in 1758 was described, and the lecturer traced the revolution of taste brought about by his new ideas. The principal features of his scheme of architecture and decoration, now known as the Adam style, were fully illustrated with the aid of very numerous and admirable slides. Sir John Soane's relations to the movement begun by Robert Adam, and to the Greek and Mediæval revivals, were also traced, and his ideas on architecture and decoration were discussed in relation to his more important works.

V.—Juvenile Lectures.

A course of two Juvenile Lectures on "Railways and Engines" was given by Mr. Loughnan Pendred, Editor of *The Engineer*. With the aid of a large number of lantern slides and working models, the lecturer gave an excellent idea of the development of railways, the first of which, the Stockton and Darlington, was not opened till 1825—only ninety-five years ago. Models of Murdock's road locomotive, of Brunton's curious engine that was propelled by a pair of legs, and of Hedley's "Puffing Billy" were shown and their action explained; while in striking contrast with these were models of some of the latest locomotives of the North Eastern, London and North Western, and Midland Railways. In the second lecture the working of the engine was carefully explained, and the various methods of signalling were described and illustrated.

VI.—Scheme for the Promotion of Industrial Art.

In pursuance of their scheme for the Promotion of Industrial Art, the Council called a Conference on House Furnishings,* which was held in connection with the Ideal Home Exhibition at Olympia on February 19th. The chair was taken by the Right Hon. Sir Auckland Geddes, then President of the Board of Trade; speeches were delivered by Sir Henry Trueman Wood and Sir Frank Baines, Principal Architect of H.M. Office of Works, and these were followed by a general discussion. At the close of the meeting a resolution was passed approving the formation of a small committee, containing representatives of the various trades concerned, "to investigate further with a view to securing a concrete issue of the propaganda undertaken by the Society." The Industrial Art Committee have since held several informal meetings with various manufacturers of furniture, and they hope to call another conference at an early date, when it is believed that Sir Frank Baines will be able to place before the trade some definite proposals.

* A full report of the Conference was published in the *Journal*, Vol. LXVIII. pp. 248-258.

VII.—Albert Medal.

The Albert Medal of the Society for 1920 has been awarded by the Council, with the approval of the President, H.R.H. the Duke of Connaught and Strathearn, K.G., to Professor Albert Abraham Michelson, For.Memb.R.S., whose optical inventions have rendered possible the reproduction of accurate metric standards, and have provided the means of carrying out measurements with a minute precision hitherto unobtainable.

It is a matter of common knowledge that the two great standards of length, the French metre and the British yard, are neither of them based on scientific principles, but are purely arbitrary measures. The metre is the length of a metal bar, which was approved by decree in 1799 and deposited in the French Archives. The British yard is the length of a metal bar. or rather the length between certain marks on the bar, finally approved by an Act of 1878, and in the keeping of the Board of Trade. The metre was originally intended to be one ten-millionth part of a quarter meridian arc measured from the North Pole to the Equator, but it has never been found possible to calculate this arc with sufficient accuracy, and the standard metre is a little shorter than the true or theoretical metre, according to the nearest calculations of the length of a quarter of the Earth's polar circumference. The British yard never professed to be anything but a purely arbitrary measure.

Numerous attempts have been made to discover some natural constant which might provide a basis for a standard of length. The length of a pendulum beating seconds (or an aliquot part, such as a third) has been suggested. In 1774 this Society offered a Gold Medal for an invariable standard of weights and measures,

but without result. The problem had, in fact, been considered insoluble until in or about 1893 Professor Michelson discovered that the length of the metre might be stated in terms of wave-lengths of light. He found, by the use of his improved interferometer, that in the length of the standard metre there were 1,553,164 wave-lengths of the red line of cadmium, and this result was verified in 1906 by Perot and Fabry. It is believed that the calculation is correct within two millionths of a millimetre, and it therefore provides a means by which, if the standard metre were lost or destroyed (with all its copies), it could be reproduced with absolute accuracy.

Professor Michelson's numerous contributions to purely scientific research have been recognised by the award of the Copley Medal of the Royal Society and of the Nobel Prize for Physics, both in 1907.

VIII.—Medals for Papers.

The Council decided to award eight medals for the papers read before the Society during the present session—four for papers read at Ordinary Meetings, two for those read in the Indian Section, one for those read in the Colonial Section, and one for that read at a joint meeting of the Indian and Colonial Sections.

The following awards have been made :—

Papers read at the Ordinary Meetings :—

John Westall Pearson, "The Seed Crushing Industry."

Sidney Preston, C.I.E., "English Canals and Inland Waterways."

Sir James Currie, K.B.E., C.M.G., "Industrial Training."

Air-Commodore Edward Maitland, C.M.G., D.S.O., A.F.C., "The Commercial Future of Airships."

Papers read in the Indian Section :—

Sir William Stevenson Meyer, G.C.I.E., K.C.S.I., "The Indian Currency System and its Developments."

Albert Howard, C.I.E., M.A., F.L.S., "The Improvement of Crop Production in India."

Paper read in the Colonial Section :—

Sir Francis Watts, K.C.M.G., D.Sc., "Tropical Departments of Agriculture, with special reference to the West Indies."

Paper read at a Joint Meeting of the Indian and Colonial Sections :—

Sir John Cadman, K.C.M.G., D.Sc., "The Oil Resources of the British Empire."

For many years it has been the practice that no medals should be awarded to readers of papers who had previously received medals from the Society or who were members of the Council. Acting on this rule, the Council were precluded from considering the following papers :—

At the Ordinary Meetings :—

Horace M. Thornton, "Gas in Relation to Industrial Production and National Economy."

William Worby Beaumont, M.Inst.C.E., "Street Passenger Transport of London."

Leon Gaster, "Industrial Lighting and its relation to Efficiency."

Dr. C. E. Kenneth Mees, "A Photographic Research Laboratory."

John Somerville Highfield, M.Inst.C.E., M.I.E.E., W. R. Ormandy, D.Sc., and D. Northall Laurie, F.I.C., "The Commercial Application of Electrical Osmosis."

In the Indian Section :—

P. J. Hartog, C.I.E., M.A., "Some Problems of Indian Education."

Sir George Cunningham Buchanan, K.C.I.E., M.Inst.C.E., "The Ports of India: their Administration and Development."

Brigadier-General Lord Montagu of Beaulieu, K.C.I.E., C.S.I., "Roads and Motor Transport in India."

The Council, however, desire to express their appreciation of these papers.

IX.—Owen Jones Prizes.

The competition for the Owen Jones Prizes was conducted on the lines followed during the last three years. By the kind permission of the Director of the Victoria and Albert Museum, the necessary accommodation and facilities for judging the work in the Museum were placed at the disposal of the Council.

In 1919 the competition was limited to designs for:—(1) Architectural Decoration, including Stained Glass, Mosaic for Walls and Floors, Plasterwork in relief and incised, Inlaid Marble and Stones, and Lettering for Memorials; (2) Woodwork and Cabinet Work, including Carving in Wood, Ivory and Bone, Inlay, Chairs, Chests, and Cabinets; (3) Textiles, including Tapestries, Carpets and Rugs, Moquettes and Floor Coverings (*e.g.*, Linoleums and Floor-Cloths). Fifty designs were sent in from nine Schools of Art by thirty-one students. These numbers showed a slight increase over those of 1918, when thirty-seven designs were submitted from nine schools by thirty-one students, but they were still far below the numbers for 1917, when one hundred and twenty designs were submitted from twenty-two schools by seventy-three students. There is little doubt that the smallness of the entries in

1918 and 1919 was mainly due to the effects of the war, which had very largely reduced the numbers of those attending the Schools of Art.

According to the report of the judges,* the quality of the work was as disappointing as the quantity, and they only felt themselves able to award two out of the six prizes offered. In order to encourage the competition, the Council decided to offer in 1920 and the two following years an additional prize of £20 for the best design submitted, irrespective of class.

The work was exhibited to the public at the Museum from July 21st to August 30th.

Full particulars of the conditions of the competition in 1920 were published in the *Journal* of November 7th last (p. 779). The designs for this year's competition had to be delivered at the Victoria and Albert Museum between June 21st and 26th.

X.—Examinations.

The extraordinary demand for educational facilities, which has filled to overflowing every university, college, and evening school in the country, has had its effect on the Society's examinations, the entries for which have increased in a most remarkable manner. For purposes of comparison the figures are given below for the present and two previous years — 1914, the previous record year, and 1919:—

Year.	*Number of entries.*
1914	37,974
1919	34,173
1920	54,010

The increase is no doubt due in part to the prizes of the value of £1,000 which were offered by the proprietors of the *Daily Sketch* for shorthand-typists †; but these probably only account for the increase in the three subjects in which the prizes are offered, viz., Shorthand, Typewriting, and English. There have also been great increases in other subjects, *e.g.*, the entries in Book-keeping rose from 10,099 in 1919 to 16,617 this year.

The number of candidates who competed for the *Daily Sketch* Prizes was 1141, divided up as follows:—In Stage I., 560; in Stage II., 389; in Stage III., 192. In the Elementary Stage the prizes will be awarded on the results of the ordinary examinations in March and May last; but in the Intermediate and Advanced Stages candidates selected on the results of these examinations will be required to undergo a further test later on. Full particulars of the competition will be given in the usual detailed report on the examinations which will appear in the *Journal* in the autumn.

The liberality of the Worshipful Company of Clothworkers has enabled the Council, as in past years, to offer the usual silver and bronze medals. These medals are very highly valued by the successful candidates, and there can be no doubt that they contribute not a little to maintain the high standard of the examinations.

The results of the First Division of the Examinations, held in March, have already been communicated to the candidates; and those of the May Division will be announced as soon as possible.

In order to ensure that the Examinations should be kept in close touch with present-day requirements, the Council re-constituted the Examinations Committee, with a view to securing upon it fair representation of Local Education Authorities and of the teaching profession. This Committee has been engaged for some time in revising the syllabuses, and the greater part of this work has now been completed.

XI.—Viva Voce Examinations in Modern Languages.

Up to the present date fourteen examinations in French, German, and Spanish have been held this year in London, Coventry, Liverpool, York, and Manchester.

At these examinations 319 candidates presented themselves, of whom 235 passed (65 with distinction) and 84 failed.

Other examinations have been arranged in French, Italian, Spanish, and Russian.

XII.—New Council.

The Vice-Presidents retiring under the ordinary regulations are Sir Walter Egerton, Lord Islington, Sir Philip Magnus, Lord Sanderson, and Mr. Alan A. Campbell Swinton (the last of whom is nominated as a Treasurer). In their places the Council recommend Viscount Cowdray, Mr. Edward Dent, the Hon. Richard Clere Parsons, Sir Marcus Samuel, and Mr. Carmichael Thomas, all of whom have served on the Council in former years.

The four Ordinary Members of Council retiring are Sir Charles Carrick Allom, Mr. Edward Dent, Sir E. H. Tennyson-d'Eyncourt, and Dr. Martin Onslow Forster. In their places the Council recommend Mr. Charles Frederick Cross, Viscount Elveden, Mr. Charles B. L. Tennyson, and Sir Richard Vassar Vassar-

* See *Journal*, Vol. LXVII. p. 570.

† Particulars of the competition were published in the *Journal*, Vol. LVII. p. 611.

Smith, none of whom have yet served on the Council.

XIII.—Obituary.

The number of distinguished Fellows whom the Society has lost during the past twelve months is fortunately smaller than usual.

Earl Brassey, who was killed by being run over by a taxi-cab, was only elected a Fellow of the Society in 1918, but his father, the first earl, had served on the Council for some forty years.

Sir Percy Sanderson was a brother of Lord Sanderson, who was Chairman of the Council from 1911–13.

Mr. J. D. Crace had been a member since 1862, and frequently attended meetings of the Society.

Sir John Jackson had been a member of the Society since 1889.

Among other notable Fellows who have died during the last twelve months may be mentioned, Sir Alexander Baird, Mr. Alexander Izat, Admiral Charles John Rowley, Mr. Henry Gribble Turner, Mr. Albert E. Reed, Mr. Hennen Jennings, and Dr. Theodore N. Vail.

XIV.—Finance.

In accordance with Section 40 of the Society's By-laws, the Financial Statement for the year 1919 was published in the *Journal* of June 25th. This shows that the excess of expenditure over income for the year amounts to £621 11*s*. 8*d*. The deficiency is mainly due to the increased cost of the *Journal*, which rose from £2,131 6*s*. 1*d*. in 1918 to £2,851 11*s*. 10*d*. in 1919.* Office expenses have also risen from £3,558 9*s*. 4*d*. in 1918 to £3,870 6*s*. 8*d*. in 1919. On the other hand, there has been a satisfactory increase in the amount received in subscriptions—£6,261 14*s*. in 1919, as compared with £5,780 11*s*. in 1918.

Unfortunately there is no prospect of any diminution in the cost of the *Journal*. On the contrary, it seems likely that it will rise to at least £3,800 for the current year. In these circumstances the Council cannot but view the financial position of the Society in the near future with serious concern, and they have reluctantly come to the conclusion that it is necessary to raise the annual subscription from two to three guineas, and the life composition fee from twenty to thirty guineas.

Another matter which has been engaging their anxious attention is the tenure of the Society's House. The lease granted in 1775 by the Brothers Adam, after being twice renewed, came to an end in 1904, since when the Society has held the premises on a tenancy terminable by either side at two years' notice. The present landlord has served the Council with a notice terminating their tenancy as from March 25th, 1922, but he has expressed his willingness to sell them the freehold. The Council are strongly of opinion that every effort should be made to secure permanent possession of the historic house which was built for the Society by the Brothers Adam, and in which its work has been carried on for nearly a century and a half.

The Council have been earnestly considering this most important question, and they hope very soon to be able to submit to the Fellows some suggestions which they trust may meet with their approval and support.

* The cost of the *Journal* in the last year before the war, 1913–14, was £1,767 4*s*. 11*d*., when it contained 1055 pages, as compared with 810 pages in 1918-19.

The Chairman (Sir Henry Trueman Wood) moved the adoption of the report. He felt sure the Fellows must admit that, taking existing conditions into account, the report was really extremely satisfactory. The Society, like all other similar Institutions, had suffered, and was still suffering from the effect of the hard times. There was much more it could have done, if it had had sufficient funds, but the Society's resources had been sadly cramped, and the Council had been obliged to consider how those resources could be increased. The papers read at the Ordinary Meetings and in the Indian and Colonial Sections would compare very favourably with those of any previous Session, and as he had had to deal with the papers for so many years, he thought they would admit he had some right to speak on the subject. He thought the Society was to be congratulated on the programme of meetings and lectures, and upon the way in which the work had been carried out. With regard to the award of the Albert Medal to Professor A. A. Michelson, he was quite certain that the candidate selected by the Council, with the approval of H.R.H. the President, well deserved to be included in the list of very distinguished recipients of the medal. The value of Professor Michelson's work was universally acknowledged. It was, of course, more valuable from the purely scientific side, but it was also a very important contribution to Arts, Manufactures, and Commerce. He referred to the work of the examinations which the Society had carried on since 1856, and which had gradually grown both in amount and in importance. The Society had spent a good deal of money on the examinations. It never expected to make any profit out of them, and whenever there was a little profit, it had always been used for further extending and improving the examinations themselves. The tide this year seemed to have turned, and he thought it was only reasonable that

some of the profit should be devoted to the general purposes of the Society. There would also be some additional expenditure on the examinations in order to increase the fees paid to the Examiners, which were fixed many years ago, and were naturally insufficient with the present depreciated value of money. There was one other matter to which he thought reference should be made, and that was the question of the Society's premises. As stated in the report, the lease granted by the Brothers Adam in 1775, after being twice renewed, came to an end in 1904. The Society's former landlord, the late Mr. George Drummond, was unwilling to bind himself to renew the lease, and the Society had held the premises on a tenancy terminable on either side at two years' notice. The present landlord, Mr. G. H. Drummond, had served the Council with a notice to terminate their tenancy as from March 25th, 1922, but he had offered to sell the Society the freehold. The matter had been before the Council and before a Special Committee of the Council, and although he was not yet in a position to make any public announcement, he thought he might be allowed to say that several past and present members of the Council had promised very liberal donations to start a fund to enable the Society to purchase the freehold; and if the Council received sufficient promises of support, they proposed to appeal generally to the Fellows, and to ask them to subscribe to a fund so that the Society might still remain in the historic house in which it had done very nearly the whole of its work. He said he would defer what other remarks he had to make on the matter of the Society's finances until they came to the question of the motion relating to the increase in the subscription.

Sir Steuart Colvin Bayley, G.C.S.I., C.I.E., said he had great pleasure in seconding the motion that the report be adopted.

The adoption of the report was then agreed to.

The Chairman said the next business was the proposal to increase the subscription of the Fellows from two guineas to three guineas per annum, and that the matter might be put entirely in order he called upon the Secretary to read the Resolutions of the Council as given in the notice convening the meeting.

The Secretary then read the following resolutions:—

1. That By-Law No. 56, relating to the annual subscription of members be altered and amended by the substitution of the word *Three* for the word *Two*.
2. That By-Law No. 59, relating to Life Compositions, be altered and amended by the substitution of the word *Thirty* for the word *Twenty*.

[The By-Laws, as amended, will read as follows:—

By-Law 56.—"The Annual Subscription of every member shall be *Three* guineas at least."

By-Law 59.—"Any member may commute or compound for all future payments, and become a member for Life, by payment of a sum of not less than *Thirty* guineas."]

The Chairman thought it was unnecessary for him to go very far into the financial question, for it was quite certain that the Society could not continue with its present resources. It might perhaps carry on for a certain time by utilising the resources it had accumulated in more prosperous times, but these would speedily be exhausted, and the Society would then be stranded. The Council had given very careful consideration to the matter, and they had come to the conclusion that it was necessary to raise the subscription. They all knew the depreciated value of money, and the purchasing power of three guineas now was certainly not equivalent to two guineas in 1914, and very far from what it was in 1754 when the Society was established. One of the heaviest items of expenditure was the cost of printing the *Journal*, which had risen from £1,767 in 1914 to £2,851 in 1919, and which would certainly reach £3,800 for the current year. It would therefore be seen that more than half the total amount of the annual subscriptions received from Fellows was expended on printing the *Journal*. The balance was insufficient to carry on the work of the Society, and he did not think it was necessary for him to impress upon Fellows the absolute necessity for making the alteration. The Council felt there was no alternative but to raise the amount of the subscription. The British Association had had to raise the subscription of their members, and he believed other societies contemplated doing the same.

Professor J. M. Thomson, F.R.S., mentioned that other learned societies, including the Linnean Society and the Chemical Society, had increased their subscriptions.

The Chairman then formally proposed the two resolutions.

Mr. Alan A. Campbell Swinton, F.R.S., said he had much pleasure in seconding the resolutions.

The resolutions were then put to the meeting and carried without any dissentients.

The Chairman proposed a cordial vote of thanks to the Secretary (Mr. G. K. Menzies) and to the other officers of the Society. It gave him great pleasure, he said, to propose a vote of thanks to his own successor, because from his long connection with the Society, he knew what the duties of the Secretary were better than anybody else, and it was a source of great satisfaction to see how extremely well the work had been carried on. The Society, he thought, was greatly indebted to the Secretary, and to the staff who had admirably supported him. Mr. Digby had been Secretary of the Indian and Colonial Sections for a long time, and during the past three years he had helped Mr. Menzies in the secretarial

duties. He thought they all thoroughly appreciated the admirable work Mr. Digby had done for the Indian and Colonial Sections, and the care and attention he had devoted to the general work of the Society. He had already referred to the examinations and the increase of work involved by their development. All this work had been admirably carried on, under the general superintendence of the Secretary, by Mr. Buchanan and his assistants, Mr. Cassidy and Mr. Toye, to all of whom great credit was due.

MR. CARMICHAEL THOMAS had very much pleasure in seconding the motion.

THE SECRETARY (Mr. G. K. Menzies) returned thanks for this expression of confidence in himself and in the other officers of the Society. He also wished to express his gratitude to Sir Henry Trueman Wood for the training he had received under him, and for the kind help and advice he had so readily given him since he took up the Secretaryship of the Society.

The ballot having remained open for half an hour, and the scrutineers having reported, the CHAIRMAN declared that the following had been elected to fill the several offices. [The names in *italics* are those of Fellows who have not, during the past year, filled the office to which they have been elected.]

PRESIDENT.

H.R.H. The Duke of Connaught and Strathearn, K.G.

VICE-PRESIDENTS.

Lord Askwith, K.C.B., D.C.L.
Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I.
Sir Steuart Colvin Bayley, G.C.S.I., C.I.E.
Sir George T. Beilby, LL.D., F.R.S.
Lord Blyth.
Thomas Jewell Bennett, C.I.E., M.P.
Sir Dugald Clerk, K.B.E., D.Sc., F.R.S.
Viscount Cowdray.
Sir William Henry Davison, K.B.E., D.L., M.P.
Edward Dent, M.A.
Peter MacIntyre Evans, M.A., LL.D.
Sir Robert Abbott Hadfield, Bt., D.Sc., D.Met., F.R.S.
Field-Marshal Earl Haig, K.T., G.C.B., O.M., G.C.V.O., K.C.I.E.
Colonel Sir Thomas H. Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc.
Lord Leverhulme.
Major-General Sir Desmond D. T. O'Callaghan, R.A., K.C.V.O.
Major Sir Francis Grant Ogilvie, C.B., LL.D.
Hon. Sir Charles Algernon Parsons, K.C.B., LL.D., D.Sc., F.R.S.
Hon. Richard Clere Parsons, M.A.
Sir Marcus Samuel, Bt.
Carmichael Thomas.
Sir Aston Webb, K.C.V.O., C.B., P.R.A.
Sir Henry Trueman Wood, M.A.

ORDINARY MEMBERS OF COUNCIL.

Charles Frederick Cross, F.R.S.
Viscount Elveden, C.B., C.M.G., M.P.
John Somerville Highfield, M.Inst.C.E., M.I.E.E.
Sir Herbert Jackson, K.B.E., F.R.S.
Major Sir Edward Humphrey Manisty Leggett, R.E., D.S.O.
Major Percy A. MacMahon, R.A., LL.D., D.Sc., F.R.S.
John Slater, F.R.I.B.A.
Charles B. L. Tennyson, C.M.G.
Professor John Millar Thomson, LL.D., F.R.S.
Sir Richard Vassar Vassar-Smith, Bt., D.L.
John Augustus Voelcker, M.A., Ph.D., F.I.C.
Sir Frank Warner, K.B.E.

TREASURERS.

William Henry Maw, LL.D., M.Inst.C.E.
Alan A. Campbell Swinton, F.R.S.

SECRETARY.

George Kenneth Menzies, M.A.

On the motion of the CHAIRMAN, a vote of thanks to the scrutineers was carried unanimously.

MR. ALAN A. CAMPBELL SWINTON, F.R.S., proposed a very hearty vote of thanks to Sir Henry Trueman Wood, not only for his conduct in the chair that day but for the large amount of time and trouble he had devoted to the affairs of the Society during his tenure of office as Chairman of the Council. He felt sure it was a great gratification to everyone belonging to the Society when Sir Henry Wood consented to become Chairman of the Council. They all knew the immense amount of time and trouble he had devoted to the Society. If there was any possible doubt as to the necessity of the resolutions they had just passed with regard to increasing the subscription—a course which the trend of events had rendered absolutely necessary—the fact that the matter was put forward by Sir Henry himself would, he thought, be sufficient to remove any such doubt in their minds, as they knew Sir Henry would only recommend what was in the best interests of the Society.

MR. JULIUS GARRATT had great pleasure in seconding the vote of thanks to the Chairman. Speaking as a provincial Fellow, he said that the name of Sir Henry Trueman Wood was a household word throughout the country.

THE CHAIRMAN, in acknowledging the vote of thanks, said it was a source of great gratification to serve as Chairman of the Council, and to hold the highest office in the Society, next to that of the President, which the Society could bestow upon any of its Fellows; and he expressed his thanks to all his colleagues for the way in which they had supported him. He said he had spent a very pleasant year of office, and he hoped still to remain on the Council.

The meeting then adjourned.

OBITUARY.

Sir Shapoorji B. Broacha.—The death of Sir Shapoorji Burjorji Broacha, the Bombay financier, has occurred in India. He did much to promote industrial development in the Western Presidency and elsewhere, and was equally distinguished as a philanthropist. His benefactions, public and private, were manifold, and included the gift of a new town hall to his birthplace—Broach—where a marble statue has been erected in his honour. Knighted in 1911, he served as Sheriff of Bombay, and was a member of the Royal Commission appointed in 1913, under the chairmanship of Mr. Austen Chamberlain, to investigate the Indian currency system. He joined the Royal Society of Arts ten years ago, and contributed a handsome sum to the Sir George Birdwood Memorial Lecture Fund. Throughout a long and honourable business career he enjoyed the respect and esteem not only of his own people, the Parsi community, but of all classes, Indian and European.

GENERAL NOTES.

Institut International du Froid. — An International Conference of Refrigeration, at which forty-two Governments, States, Dominions and Colonies were represented, was held in Paris, on June 21st, the French Minister of Agriculture, M. Ricard, presiding. The object of this Conference was the signing of a Convention which creates an International Institute of Refrigeration in Paris, supported by annual subsidies from all participant States. The aim of the Institute is to stimulate the progress of the science and technics of refrigeration, and to realise, for the benefit of all humanity, the development of the various and innumerable applications of refrigeration, which play so large a part in the economy of the world. The Executive Committee of the Institut is presided over by M. André Lebon, chairman, who is assisted in his work by vice-presidents and officers, elected among the representatives of the different powers in Paris. The Director of the Institute (9, Avenue Carnot, Paris) is M. Emile Gouault.

Accounts of Chippendale, Haig & Co.—The Victoria and Albert Museum have published in pamphlet form (price 2*s*.) the accounts of the firm of Chippendale, Haig & Co., for furnishing David Garrick's house in the Adelphi. For one who made such a mark in the development of furniture extraordinarily little is known about Chippendale. He came from Worcester with his father before 1727, occupied workshops successively in Conduit Street, Long Acre, and St. Martin's Lane, and was elected a member of the "Society for the Encouragement of Arts, Manufactures and Commerce"—and that is all concerning his private history that can be stated with certainty about him. The total cost of the furniture recorded in these accounts is £931 9*s*. 3½*d*. We have it on Dr. Johnson's authority that at this time Garrick lived as a prince rather than as an actor, "his table, his equipage, and manner of living are all most expensive and equal to those of a nobleman." We can therefore draw some interesting inferences as to the difference in the cost of furniture then and at the present day. The accounts give considerable details of the various articles of furniture supplied. "In the case of the drawing-room the walls were papered and finished with a gilt leaf border; fringed curtains of green silk damask hung at the windows and the same material covered the *bergères* and sofa, which were japanned green and yellow; two pier glasses were placed, no doubt, between the windows; and the scheme of arrangement was completed by a third mirror, two pembroke tables and three commodes of inlaid wood." The pamphlet will prove of great interest to the student of furniture.

Three Pile Figured Velvets. — Figured velvets having three distinct and separate heights of pile were invented by Sir Frank Warner in 1915 and patented by him in Great Britain, America and the leading textile countries of Europe. Figured velvets, in which the ground web was entirely covered with cut pile, the figure of the design standing up in higher pile, giving what is known as "pile on pile" effect, had been woven in Italy as far back as the fifteenth century. In the sixteenth century richer effects were obtained by the employment of gold or silver thread in addition to the pile on pile, and a further effect in the figuring was obtained by the use of uncut or looped velvet known as "Terry Velvet." In the latter half of the seventeenth century figured velvet weaving was introduced into England by the Huguenot refugees from France, and a fine example of their work is to be seen in the hangings on the Queen Anne bedstead at Hampton Court Palace. Before the end of the eighteenth century figured velvet weaving appears to have ceased in England, and it was not until 1875 that the art was revived by the late Benjamin Warner, the father of Sir Frank, who produced a fine example of velvet and terry on a satin ground. The design was by Owen Jones, and a specimen of it is now in the Victoria and Albert Museum. In 1908 Sir Frank Warner produced, for the first time in England, some pile on pile velvets, which were exhibited at the Franco-British Exhibition in that year. From that achievement arose the idea of producing the "three pile" velvet, in which the third height of pile forms a figure superimposed on another pile figure, which in its turn is above the first or ground pile. The expression "three pile" must not be confused with the old time term "three-pile" mentioned in several of Shakespeare's plays, which referred only to plain silk velvets then sold as one, two or three pile according to quality.

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FRIDAY, JULY 9, 1920.

***All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.* (2)**

NOTICES.

INCREASE OF SUBSCRIPTION.

At the Annual General Meeting held on June 30th, it was unanimously resolved that the annual subscription of Fellows be increased from £2 2*s*. to £3 3*s*., and the Life Composition fee from £21 to £31 10*s*. The new scale will apply to all subscriptions due on and after Michaelmas, 1920.

These changes have been necessitated mainly by the great increase in the cost of the *Journal*, which rose from £1,767 4*s*. 11*d*. in 1913-14 (the last year before the war) to £2,851 11*s*. 10*d*. in 1919, and will probably rise further to about £3,800 for the current year. The general costs of maintenance and of conducting the work of the Society have also inevitably risen. Further particulars as to the financial position of the Society were published in the report of the Annual General Meeting in the *Journal* of July 2nd.

INDIAN SECTION.

A meeting of the Indian Section Committee was held on Monday, July 5th. Present:—

Sir Charles S. Bayley, G.C.I.E., K.C.S.I. (Chairman of the Section); Sir Charles H. Armstrong; Sir Steuart Colvin Bayley, G.C.S.I., C.I.E.; Lieut.-Col. Sir Charles H. Bedford, LL.D., D.Sc., M.D.; Sir M. M. Bhownaggree, K.C.I.E.; D. T. Chadwick, I.C.S.; Sir Valentine Chirol; Laurence Currie, M.A., J.P.; W. Coldstream, B.A.; Sir Krishna Govinda Gupta, K.C.S.I.; Sir Henry Evan M. James, K.C.I.E., C.S.I.; Major-General Beresford Lovett, C.B., C.S.I.; Sir Charles C. McLeod; and Colonel Sir A. Henry McMahon, G.C.M.G., G.C.V.O., K.C.I.E., C.S.I., with G. K. Menzies, M.A. (Secretary of the Society), and S. Digby, C.I.E. (Secretary of the Indian and Colonial Sections).

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Thursday, May 20th, 1920; Lieut.-General Sir Herbert V. Cox, K.C.B., K.C.M.G., C.S.I., Military Secretary, India Office, in the chair.

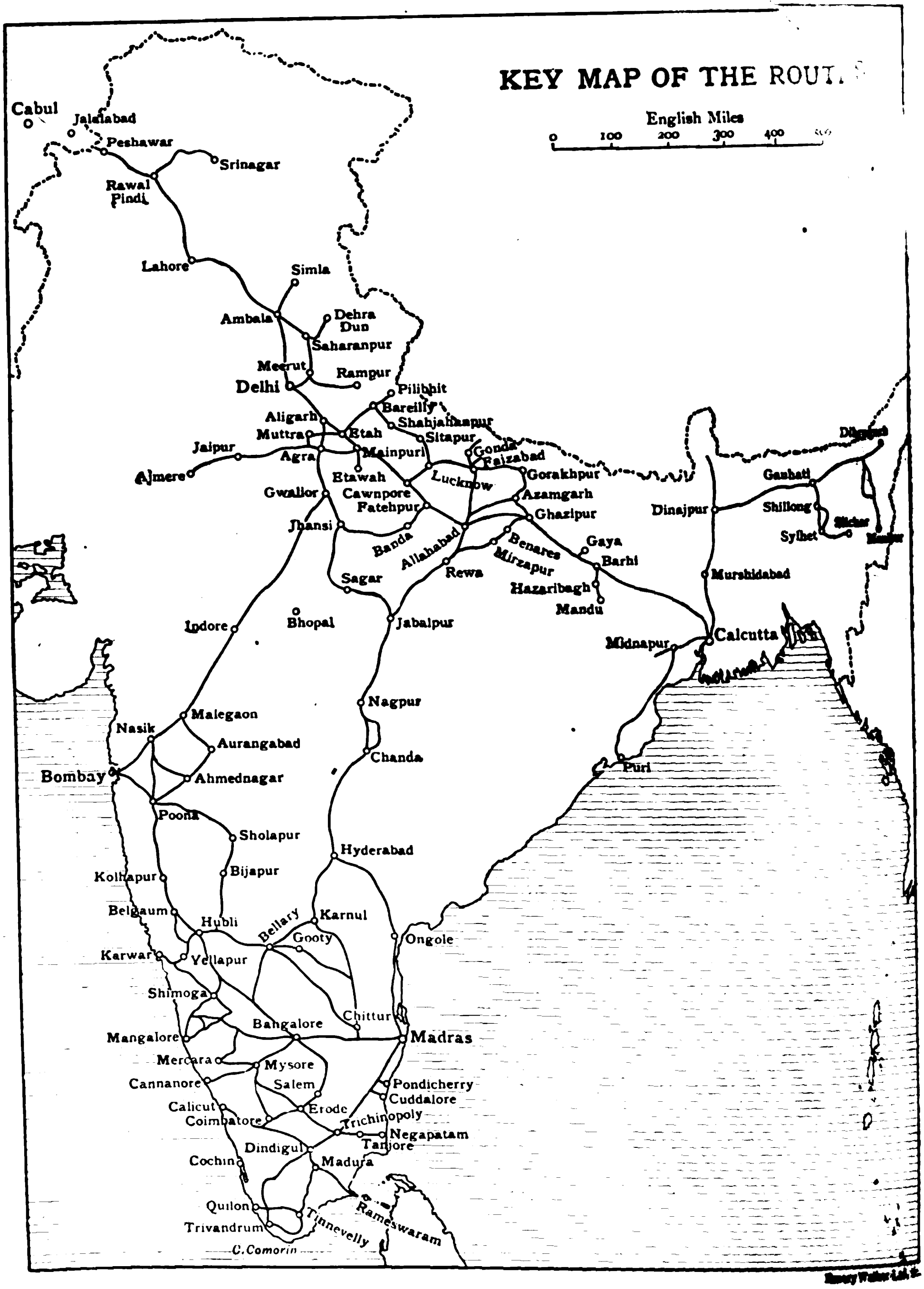
The paper read was—

ROADS AND MOTOR TRANSPORT IN INDIA.

By Brigadier-General Lord Montagu of Beaulieu, K.C.I.E., C.S.I.,

Adviser on Mechanical Transport Services in India, 1915-19.

In India, as in many other countries, the chief roads were originally made for military operations. I can trace no records of any definite road system previous to the occupation of certain parts of India by the East India Company. But through the greater part of India towns and populous districts must have been connected by tracks or kutcha roads for centuries, though no efforts seem to have been made to make them fit for continuous wheel traffic. It is probable that up to the first British connection with India the habitual means of transport was by means of coolies and animals, carrying loads on their heads and backs. The most ancient of all permanent roads in India are to be found on the Northern Frontiers, where, in more than one place, there are traces of Buddhist roads. These mountain paths were not blasted out of the rock, as would have been the case to-day, but burnt out by a peculiar process. Such a road is clearly seen over the Malakand Pass, below the present military road on the western slope, and it is interesting to recall the methods which the Buddhists adopted in order to make these roads. They lit wood fires upon the rock, mostly of a limestone character, and having made it very hot, suddenly poured water upon it, causing the stone to crack, and in this way laboriously achieved a more or less flat path on the mountain side. It is noticeable from an engineering point of view how well these old roads were made, showing that the constructors of those days had among them engineers of practical, if not of theoretical, experience.

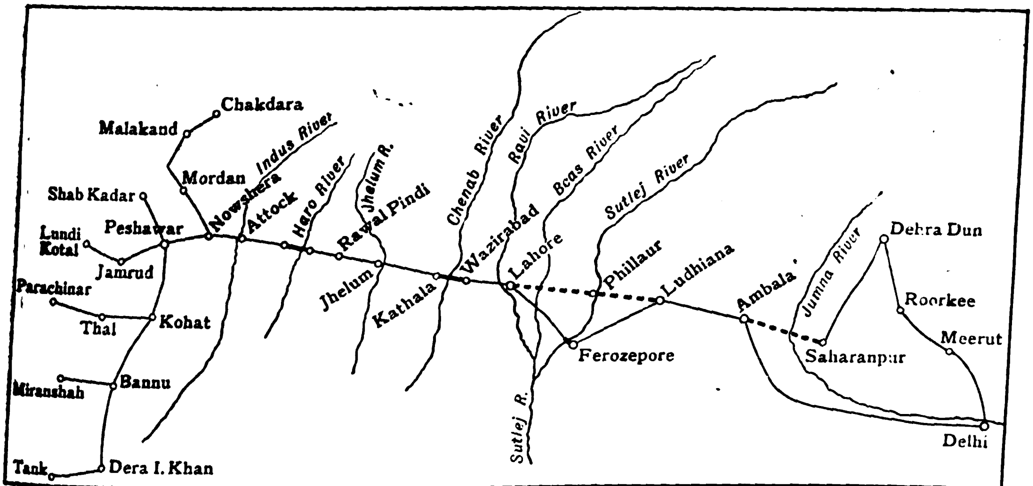


The first attempt at a national road system began with the construction of the Grand Trunk Road in 1839. At first this road commenced at Fort William, Calcutta, and extended westward to Cawnpore, thence on towards Ambala and Lahore. From there it was extended later, mainly by John Nicholson, through Warizabad and Jhelum to Rawalpindi, and eventually past Attock to Peshawar. At the summit of the Mogalla Pass, some twelve miles west of Rawalpindi, there is a marble tablet to Nicholson, whose victories and road-making it commemorates. The Trunk Road between Calcutta and Peshawar is 1,490 miles in length. When it was in good order it was probably the longest continuous stretch of properly engineered and well-laid road in the world. Other road systems, formerly in good order,

still remain in places, notably the road from Bombay through Indore and Agra to Delhi. Another road, now derelict, left the Grand Trunk Road at Benares and went through Rewah and Jubbulpore to Nagpur and Hyderabad, and thence through the Nizam's dominions on to Madras. To-day the greater part of this road is a mere track or at best a bad kutcha road. When at Secunderabad in the spring of 1915, I explored most of the so-called main roads in the Nizam's dominions, and found that beyond a short radius from Hyderabad they were impassable for mechanical transport, and had become second-class kutcha roads.

From an old map which I have here, dated 1853, and published by Messrs. H. Allen & Co., of Leadenhall Street, it will be seen that there are no railways marked, but many more roads than would appear on any map nowadays. Only a few of these roads are traceable to-day as existing main trunk roads. The majority of them have disappeared, or at any rate have become kutcha roads, only usable by local traffic. main roads all over India. To-day, however, compared with the area of the country, the number of its inhabitants, and the importance of its commerce, India has probably fewer miles of good road than almost any other civilised country in the world. I do not wish upon this occasion to touch in any way upon controversial subjects, but I think I may say that a comprehensive road policy for India has become an urgent need, in regard not only to the present, but the future development of India.

When railways were first made in India, there was at once a marked decline in the interest taken in and the money spent on roads by the Government of India and Native States alike. At that time, so much were the railways thought to be going to take the place of roads for ever, and render them unnecessary, that in some places, notably on the Grand Trunk Road between Lahore and Peshawar, the railway was actually built on the surface of the Grand Trunk Road itself, and no provision was made for the continuity of the older highway. In one case



Emery Walker Ltd. sc.

But the number and extent of these roads in 1853, nearly seventy years ago, is a probable indication of how the road system of India suffered from the coming of the railway.

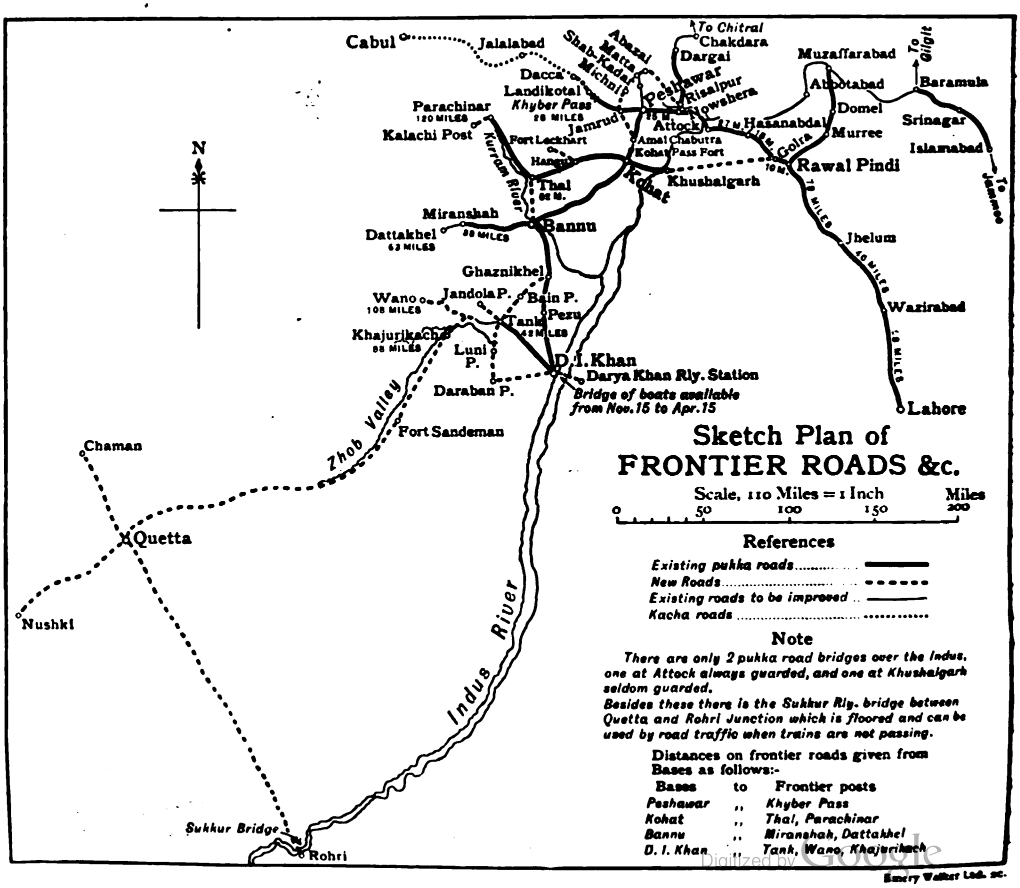
Madras, as is well known, is the oldest province in India, and it is interesting to note that to-day, as formerly, the road systems of Madras and Southern India are more highly developed, and there are more roads per square mile of country and per head of population than in any other part of India. What the road systems of India might have become had not the railway era in 1853-60 supervened, it is not easy to say. Probably there would have been thousands of miles of first-class the actual arches which formed part of the bridge of the Grand Trunk Road between Kathala and Wazirabad were used for the permanent way, and it was only in the spring of 1919—after I had constantly brought the matter to the notice of the Government of India for three years, that an effort was made to restore this gap, one of many, in this great Indian highway. I hope that the new road-bridge over the Chenab at that point will be completed before long. There are other instances where the road-bridge having collapsed, no steps were taken to repair it, and the roadway was taken over the railway bridge, as was lately the case of the Haro River, between Rawal-

pindi and Attock, where the road and railway used the same bridge, a dangerous combination from a military point of view. A new bridge was built here in 1918–19. Every means of transport up to twenty years ago was held to be subservient to railways, but the more enlightened railway authorities to-day recognise roads as the most useful allies of railways, and the abandonment or destruction of roads for railway purposes will probably not occur again.

As regards the North-West Frontier, where roads are vital from a military point of view, these roads were and are being built and maintained mainly out of military funds. The extension and improvement of these roads have been rendered increasingly necessary by the constant frontier wars which are apt to break out from time to time on the frontier between Quetta and Chitral. It is only, however, during the past four or five years that most of these roads have been made fit to bear mechanical traffic. In some cases new roads have been built to supplement the older highways, notably in the case of the Khyber Pass, where at last a proper alternative road has recently been constructed. There has been a second road up the Khyber, mainly used by animal traffic, for a long time past, part of which was also used by wheeled traffic. Formerly part of this road ran along the bed of a nullah and was therefore liable to be swept away by floods; but now the new road is sufficiently high above [illegible] to be immune from damage from floods. In the case of the Khyber, there has also been constructed of late a wire ropeway which should relieve the strain on the roads in the Pass in case of further military operations. I hope we shall soon see more ropeways in operation, notably up to Murree, and over the Malakand.

Frontier roads, to take them in order from north to south, are as follows :—

1. From Abbottabad through the Batrasi Reserve to the Kashmir frontier.
2. From Nowshera to the Malakand and Chakdara.
3. The twin Khyber Pass roads.
4. The Peshawar–Kohat road.
5. The Kohat–Thal–Parachinar road.
6. The Tochi Valley road.
7. The Gumal–Tank road.
8. The Kohat–Bannu–D.I.K. road.
9. The roads in the Peshawar Plain to Shab Kadar.



Some of these roads have now been made more or less pukka, and should be able to bear the ordinary military traffic which is carried on mainly by means of mechanical transport. There are other roads under construction or consideration, such as the Thal–Spinwam–Idak road, the extension of the Tochi road further up the valley past Datta Khel, of the Tank road by Kirghi towards Jandola, and of the Gumal Valley road towards Fort Sandeman and Quetta. The policy of peaceful penetration by road-making has proved its value over and over again, and is now recognised as a cheaper and more effective way of keeping order and stimulating civilisation on the frontier, than military expeditions from time to time. I respectfully suggest, therefore, to the Government of India and to the India Office that a progressive and well-thought-out road policy on the frontier is the best antidote for small but expensive wars there, and should troubles occur of a graver kind, of the greatest possible assistance to the military forces who have to be employed.

With regard to the rest of the roads of India outside the Punjab and the North-Western Frontier, the subject is so huge that I cannot do more than touch upon it in a very general sense. Till lately the importance of roads has in many parts, I am afraid, been lost sight of by successive administrations in India. Besides abandoned roads, and broken bridges to be seen all over India, on what were once much-used main roads, the spectacle can here and there be seen of irrigation colonies growing heavy crops, having been laid out in the most approved style, but with insuffi ient allowance in the plan for roads along which the produce can easily be transported to the local market, the railway, canal or pukka road. Very primitive and expensive methods of transportation therefore have been used, and disputes constantly arise as to pack animals treading down crops on lands of people other than their owners, and the canal banks, notwithstanding the efforts of the canal officers, are almost invariably used as highways instead of roads for a large portion of the traffic of the district. Wherever irrigation colonies or settlements are instituted in future it should be laid down by the Government of India that adequate roads must be made providing for proper communication between every part of the area irrigated or settled, as a *sine qua non* of the scheme. In some cases it might be well to combine the land reserved for roads with a provision for light railways as well. Over rivers and canals where there is no question of military importance, combined road and railway bridges should be adopted. It is interesting in this connection to record that one of the greatest difficulties in India which is met with when country districts are affected by famine has hitherto been the lack of facilities for moving food even when the food was available near by. It is probably no exaggeration to say that millions of human beings have died in India during the last fifty years, not so much because there was a lack of food within reasonable distance, but because of the difficulties of transporting that food into the districts affected. With a better system of roads and transport this difficulty would be largely removed. With the present railway system aided by an extension of roads, the alleviation of famine conditions in future should be possible with much greater certainty, economy, and ease, especially as it is very rarely that shortage of food exists all over India at the same time.

As regards the road metal available for use on roads in India, in a continent of such vast size the material nearest to the particular road in question is nearly always used. All round the North-West Frontier Provinces fairly good road metal, mainly of a limestone character, is obtainable from the surrounding hills. In the Eastern Punjab and United Provinces, what is called kanka is largely used—a kind of soft limestone which, however, makes a very fair road if the traffic upon it is not of too heavy a nature. There are also roads and road foundations to be found in India, where stone is not available, made of burnt brick. In the Deccan and parts of Central India, stone of granitic origin is available, as also in the neighbourhood of the Nilghiris. But over most of the south of India and in most parts of the Gangetic and Indus plains, good stone is difficult to obtain, and can only be brought from a distance, an expensive operation, and in the congested state of Indian railways to-day difficult to arrange. In the Bombay Presidency, in the neighbourhood of the Ghauts, stone generally of a limestone or shale nature is used, and very fair roads are thus obtained. The greatest wear and tear on the surface of good roads in India is caused by the heavily loaded, narrow-tyred bullock-cart. The bearing surfaces upon the road of the wheels of these carts is often not more than an inch to an inch and a half in width, while the cart itself may be carrying upwards of a ton load on two of these wheels. This overloaded wheel produces a greater strain upon the road than the ordinary three-ton M.T.

vehicle or the Indian standard lorry, which fully loaded, weighs only $6\frac{1}{2}$ tons, but with a bearing surface of rubber on the hind wheels of about eight inches, and on the front wheels of about four inches in width, causing a less strain on the roads than the bullock-cart. I have suggested on more than one occasion to the Government of India that regulations should be made that after a certain date, say, two years, from the date of the proclamation, time sufficient to carry out any alterations required, there should be a progressively heavy tax upon all animal-drawn carts whose tyres do not conform to a certain standard to be laid down, say a minimum width of four inches. Not only would a certain amount of revenue be derived from such a tax available for road upkeep, but a large amount would be saved annually in repairs to the roads, and a broader wheel would tend to consolidate and not to destroy the surfaces used. In connection with this question of narrow iron tyres, it is interesting to note in the case of the New Forest in Hampshire that such a regulation was made some years ago, jointly by the Crown and the local timber owners, and an immediate recovery in the ordinary secondary roads of the district was at once noticed. The local timber haulers now prefer the broader wheel, and the roads are also saved much unnecessary wear and tear. As regards any new roads made in India, especially on the frontier, a toll system might be instituted and some direct revenue raised from the users of the road for its use.

It may be asked what should be the policy of the Government of India with regard to the future administration of the roads. I would respectfully suggest that what is wanted in India first of all is a classification of existing roads in order of importance. They should be divided into first and second-class pukka roads, and third-class or kutcha roads. All roads of national and military importance should be placed in the first class, and should be maintained by the Government of India irrespective of provincial governments, but possibly with a contribution from them for the local use made of them. Such typical roads would be the main line of the Grand Trunk Road from Calcutta to Peshawar and from Bombay towards Delhi. Class 2 should be pukka roads of provincial but not necessarily of national or military importance. These should be under the control of and be repaired by the provincial Governments of Madras, Bombay and Bengal. The third classification would consist of roads of comparatively little national or provincial importance, but necessary for local use. Some of these might be made pukka, but the majority would probably remain kutcha. It should be the declared policy of the Government of India to bring up as soon as possible the surface of the third-class road into the first or second class between all important towns. A permanent department to deal with roads should also be instituted by the Government, which need not be on the ambitious and expensive scale of the Ministry of Transport recently instituted here, but have a modest beginning with a director, one or two assistant directors, and say half a dozen officials in various parts of India to carry out the duties of correspondence and local supervision.

Since April, 1915, when the Government of India first decided to possess its own mechanical transport, the number of personnel and vehicles have increased with every year, till at the end of 1919 there were something like 5,000 personnel and about 4,000 mechanical transport vehicles under its administration, including the Ford vans and cars specially obtained for the Afghan war, and now in use on the frontier. The use of mechanical vehicles among the commercial community is also largely increasing, and in Bombay, Calcutta and other commercial centres, a large amount of goods is being conveyed by mechanical transport, which till a few years ago was moved solely by animal power. There has also been a great increase in the number of motor-cars used by both the British and Indian community, and the demand seems still unsatisfied. I may remark that purely European types, both of lorries and of ordinary motor-cars, are unsuitable for use in India during a considerable portion of the year owing to their having insufficiently large radiators. It is true that some European types continue to run, but they are operated at a disadvantage compared with those that have been specially designed to suit tropical conditions. It must be remembered that when the water in the radiator is constantly boiling, not only is there a serious decrease in power produced by the engine, but mechanical troubles tend to develop as the direct result of overheating. In my opinion there is a great future before any firm who cares to specialise in a tropical model for the private owner's car. As regards lorries, the Indian Standard $2\frac{1}{2}$-ton vehicle specially designed for tropical use, has already proved its worth, and is probably the best lorry for work in hot climates that has yet been designed.

As rega[illegible] traffic, everyone in India [illegible] the commonest vehicle on the ro[illegible] cart." It is in reality a [illegible] though cumbrous, [illegible] vehicle. [illegible] occasion I counted thirty-two huge [illegible] each weighing well over [illegible] loaded on one cart, the load of which [illegible] have been in the neighbourhood [illegible] tons. This weight was being drawn on [illegible] wheels by two oxen with comparative ease. [illegible]se bullock-carts are much better balanced by the drivers than is generally supposed, and the oxen, though at first sight they appear to be overladen and unable to cope with the load, yet manage to draw these heavy weights without much apparent trouble. In some cases where there are not even kutcha roads, pack animals are, of course, still used, and on the frontiers the strings of camels called "kafilas," winding down the passes from Central Asia, are a characteristic feature in Northern India. Everything, in fact, from elephants to the most diminutive donkeys, are used by the people of the country for transport purposes.

There is one factor about the roads in India on which one cannot help remarking: that is the absolute lack so far of any effort to make them—some of the most dusty roads in the world—dustless. This is the case even in the neighbourhood of cantonments. Not only is dust a nuisance, but it is distinctly prejudicial to health, and in the case of many cantonments there is much expense incurred annually for watering, which is in itself destructive of the surface of the road. There is, for instance, no reason why the main roads of Delhi, Lahore, Rawalpindi, Peshawar, and other military camps and important centres should not be made entirely dustless, and I am convinced that the extra expense in tar-spraying or the use of tarred stone would be amply repaid by the increase in the life of the road. Then there are also cases on the frontier where dust in the summer and mud in the winter are great drawbacks to military operations. Here again, a dustless road with a bituminous surface would be of immense benefit to both troops and animals. In regard to the supply of tar, I have been unable to obtain any reliable statistics, but there should be enough tar made in various gas works all over India to provide a good many gallons for making roads dustless every year. If there are not existing plants for the distillation of tar from coal in the Bengal coalfields some could well be set up.

There are, of course, other aspects of Indian transport which hardly come within the scope of a paper on roads and transport, such as the railway systems, the traffic by sea and river, and the traffic which is animal-borne or drawn all over India. But I will touch for a moment very briefly on some of these points. As to the railways, it may be said that on the whole India has a very fair system, though there are too few lines for present needs. But the many differences of gauge are without doubt a very serious bar to the economical and efficient handling of traffic. There are at present, besides the standard gauge of 5 ft. 6 ins., the metre gauge of 3·3⅜, the 2 ft. 6 ins. gauge, and the 2 ft. gauge, making three gauges of less width than the standard gauge. It should surely have been possible to have had one standard narrow gauge as well as one standard broad gauge for railway purposes. India is also suffering from a lack of sufficiently powerful locomotives, and on most lines of rails of too light a weight on the permanent way, which make heavy locomotives impossible. But the most noticeable defect is to be found in the many weak bridges which span the rivers, great and small. There is hardly a railway company which dares run its trains at ordinary speed over the majority of these, and the constant slowing down every time a bridge of any size is approached causes serious loss of time and unnecessary wear and tear upon railway stock and the permanent way. There are even some bridges of first-class importance like the Sukkur Bridge over the Indus between Rohri and Ruk, which are by no means in a safe condition. Were this particular bridge to become permanently unusable, the whole of the Quetta district and country west of the Indus would be without any direct railway communication with the rest of India, except by a circuitous route *via* Hyderabad and Kotri. The average speed also of even the fastest mail trains is slow, as will be seen from the table (see p. 548) calculated on the speeds attained in 1919.

Before the war, these average speeds were slightly higher, but not worthy of great railway systems, mostly state-owned or controlled. The provision of accommodation also for travellers, especially third-class travellers, is poor compared with other countries. Local circumstances exist, however, which make the operation of railways more difficult than in temperate climates or European or American countries. There are many other aspects of railways in India and their working which deserve a separate paper, and for which I have no space here.

Mail Train Speeds, 1919.	Miles.	Hours.	M.P.H
1. *Bombay to Peshawar, viâ* Delhi—			
(*a*) G.I.P. and N.W.R.	1,542	55	23
(*b*) B.B. and C.I.R.	1,450	53	27½
2. *Bombay to Karachi, viâ* Baroda	992	46	21
3. *Bombay to Calcutta*—			
(*a*) E.I. and G.I.P.R.	1,349	43	31
(*b*) B.N. and G.I.P.R.	1,223	46	26½
4. *Bombay to Madras*	794	36	22
5. *Calcutta to Madras*	1,030	41	25
6. *Calcutta to Delhi*	903	28	32½
7. *Madras to Colombo*	700	35	20
8. *Madras to Jhansi Junction, viâ* Dhond and Manmad	1,314	64	20½

There are some military aspects in regard to the provision and maintenance of roads in India which should not be lost sight of, particularly in these disturbed times. Railways are no doubt a means by which troops can be conveyed more quickly and more easily than by any other method. But it must be remembered that railways can be interfered with or destroyed at any rate temporarily, and bridges blown up with comparative ease. Such interruptions and breakages can only be repaired after some time by railway engineers. However, so much has the Government of India come to rely solely on railways as the only means of communication, that even sections of the Grand Trunk Road, important from a military point of view, have been allowed to lapse into jungle or third-class kutcha road, and become unusable. To take an instance, the Grand Trunk Road from Ambala eastwards towards Saharanpur is now unusable, and were the local railway or bridges over any of the intervening rivers to be blown up, it would be difficult to move troops from Ambala eastwards or from Lucknow westwards without prolonged delay and the construction of temporary bridges and the provision of rafts and barges. A road, however, cannot be easily destroyed in the same way, and if destroyed can very soon be repaired. In my opinion roads are as important as railways from a military point of view, and to rely solely on railways in the case of moving troops in time of necessity is to rely on a calculation which may break down and cause the executive very serious trouble. I know that one of the stock objections to a progressive road policy in India has been that as the Government of India owns most of the railways, it should not encourage the public to use the roads and leave the railways. The attitude is, I am afraid, inevitable and natural in regard to state-owned concerns, when the military interests and those of the public clash with the interests of a revenue-producing department of the state. But in India many things besides mere revenue have to be considered. The maintenance of law and order and the easy movement of men and material in peace and war alike are of at least equal importance, and the loss of a few thousand passengers or tons of freight a year between certain towns in consequence of an improved system of road communication should not in my opinion be weighed in the balance.

The latest returns in 1901-2, now nearly twenty years ago, show that about 37,000 miles of metalled road, and 136,000 miles of unmetalled, or kutcha roads existed. The population of India is now about 320 millions, and the miles of road per head of population are therefore ridiculously few. From a military point of view the Government of India has lately begun to realise the growing importance of roads, the expenditure having been: 1917-18, Rs. 49,72,797; 1918-19. Rs. 77,21,588; and as estimated for 1919-20, Rs. 2,50,00,000.

The Imperial civil roads in 1917-18 cost Rs. 6,00,463, while the provincial civil roads cost Rs. 51,89,223, making a total of about 58 lakhs. This year more will doubtless be spent, but even if 100 lakhs are found for civil roads, the military expenditure will then still be two and a half times the civil expenditure, a difference neither easy to explain nor apparently justifiable, when one remembers the large excess of civil over military traffic on the Grand Trunk and other main roads in India. A large part of the military expenditure on roads benefits the civil population, and I venture to suggest that the proportion of civil compared with military expenditure needs further consideration by the Government of India.

It is sometimes forgotten that roads have

immense and continuous influence on the [illegible] life and civilisation of a nation. The free circulation of traffic like free circulation of the blood makes for health, whether national or physical. The existence of monuments of [illegible] the possession of palaces, [illegible] of grandeur and fame, are cherished by every nation and country [illegible] past and hopeful of its future. But [illegible] remains the daily means of life and [illegible] the highway of human birth, marriage [illegible] death, wonderful, ever unfinished, vital to every civilised nation. Let India look to it therefore, that her highways become worthy of her greatness.

DISCUSSION.

THE CHAIRMAN (Lieut.-General Sir Herbert V. Cox) was very glad indeed that the author had given frontier roads a prominent place in his most interesting paper, because they were surely the best means of carrying out the frontier policy of the country—namely, the civilisation and pacification of the troublesome borderland, and of enforcing our will upon recalcitrant tribes. There was a very pertinent case now in Waziristan. What might be called the main penetrating roads towards the front up the salients on the North-West Frontier had been very much improved of late years, and, generally speaking, were now fit for mechanical transport well up into what might be called the danger zone. There were many present who could remember the old days of the Afghan War. When he went out from Sandhurst and travelled to Afghanistan, at the beginning of 1880, the railhead was at Jhelum, which was then over two hundred miles from the danger zone, and the journey at that time had to be done in dak gharries or tongas through a troublesome part in those days. Some of the hills that ran across the grand trunk roads were full of dacoits, and he had a very vivid remembrance of sitting in a tonga with a pistol on his knees. It was an interesting contrast to note that less than three months ago he travelled from Kohat up the Kurrum Valley to Thal, a distance of sixty miles, in a Ford car, over a very excellently graded and surfaced road. Things changed slowly in the East, but they did change, as could be seen by looking back over a sufficient period. The author was perfectly right in saying that lateral roads connecting the main roads were very much wanted. There was no better simile to explain the frontier and its geography and its necessities than the open right hand knuckles upwards. The little finger might represent the salient going through Nowshera up through Murdan and the Malakand Pass and on to the Pamirs; the next salient was the Khyber and the main road into Afghanistan; the next one the Kurram and the route to Kotal; the next the Tochi, the main valley of Waziristan; and the last one, which might be represented by the thumb, well to the left, accurately described the Gumal and its connection with the valley towards Quetta. Everyone would have to come back almost to the back knuckle of the hand to get round to any of those points; in fact, in the case of Waziristan, to get to the Zhob Valley, one had to come back to the main lines of railway running along the banks of the Indus. That required to be bettered. As to the rest of the country, he quite agreed with the author that a system of classification of roads was required; in fact, he believed that was largely being done now. He was a little surprised that a great motorist like the author did not, when speaking about the wheels and the conditions of the roads, refer to the pernicious habit the byle cart people had, when they rested on the grand trunk road for the night, of stopping all their wheels with bits of rock or brick, which they invariably left for the next motorist to come up against. In driving on even the best of Indian roads the driver had to keep his attention solely on the surface of the roads, if he did not desire to find himself in the middle of a collection of stones and bricks. There was one point which should appeal especially to this Society, and that was the matter of tree-planting or re-afforesting along the roads of India. It should be much better and more systematically done than it was now. Intense heat prevailed for six or seven months of the year, and shade was a priceless boon to a traveller on the road. There were many beautiful trees suitable for roadside shade which were natural to India, such as the neem, the tamarisk, the mango, the peepul, and the bamboo; yet there were hundreds of miles of quite important roads without a single tree, and the traveller, man or animal, was exposed to the scorching direct rays of the Indian sun. Where planting had been ordered—and it had been ordered more often than people thought—it was so badly done that young trees had not had a chance. The lazy Public Works coolie put the trees in badly to begin with, and the rapacious contractor, whose business it was to build guards round the young trees, scamped his work and used few bricks and no mortar. The next arrival upon the scene was always those devastating country goats, driven by an irresponsible boy. The first goat butted the contractor's fence with his iron forehead, and then the whole of the goats trooped in and in a very short time the sapling had gone. The matter required more care and supervision than were given to it at the present time. Light railways had proved extremely valuable in feeding the main lines of rail and the main roads, and he would suggest that systems of kutcha feeder roads towards light railways and main roads

were much wanted in every Province, and particularly in Burma. Burma had its railway and the Irrawaddy running close to each other, but was very much wanting in feeder roads for both. Irrigation and railways had done much to relieve India of the dread of being devastated by famine on the scale of the olden times, but in these days of general shortage of food means of transportation were more important than ever, and should not be neglected in any part of the world. He quite agreed that India's roads were not at present worthy of her greatness, and he hoped that they might become so in the near future.

General Sir Edmund Barrow, G.C.B., G.C.S.I., said that many years ago he traversed nearly all the routes and passes leading from Peshawar and the Malakand to the Pamirs, and traces of Buddhist influence and culture were constantly visible in old roads, irrigation channels, and walls of defence. The natural frontier between this region and Peshawar was crossed at the Malakand, and eastward of that pass by several ancient lines of communication, which were extraordinarily well laid out with good gradients, and now, after twenty-five hundred years, were still usable in parts. He had been over several of those ancient roads and would in parts certainly prefer to walk by the old Buddhist road rather than the new one made in 1885. He very much deplored the neglect of roads generally in India to-day, which caused many difficulties in transport, and he could thoroughly endorse what had been said by the author as to the great need of good motor roads for Indian communications. With regard to the Thal-Idak road mentioned by Lord Montagu, it was a lateral road of the very greatest value. He did not know whether it had been put in really good motoring order yet, but traversing it many years ago he was convinced that there might be made an easy first-class road from Thal to Idak. Had there been such a road during the recent operations on the frontier, he had not the slightest doubt that those operations would have been greatly facilitated. Thal was the railhead and was within two marches of Idak by road, and a good cross road from Thal to Idak would greatly assist the defence of that part of the frontier, and possibly save the construction of more difficult roads penetrating Waziristan from other directions. About a century and a half ago Field-Marshal Wade entirely changed the aspect of affairs in the Scottish Highlands by the roads he made; up to that time the highlanders had given great trouble, but since then they had been one of the most important elements of the British Army. The Romans everywhere transformed the barbarous countries which they conquered mainly by the influence of the roads they constructed. The value of good roads in civilising countries was immense. The vast construction of railways in India had had a tremendous effect. He had constantly heard it urged by high authorities that the construction of those railways and the telegraphs made our position in India so secure that we could readily reduce the strength of our armies in India; but he ventured to think that that view was entirely erroneous, as railways were easily cut. Only last year communications were interrupted for several days around important centres such as Amritsar and Lahore. It was most important, therefore, from a political and military point of view that roads should be maintained as well as railways and telegraphs.

Sir William Joynson-Hicks, Bt., M.P., said that in travelling in India he had been struck with the extraordinary life of India on the Indian roads, and he almost came to the conclusion that the Indians lived on the roads; certainly they used them far more than roads were used in England. In this country it was possible to go miles and miles without meeting more than one or two farm carts, but in India the whole village life seemed to concentrate on the roads. Very often one was surprised to see a bedstead or grand piano apparently walking along on its own, with four or six pairs of legs of coolies underneath. Every country required good roads and plenty of them. With regard to the frontier, he supposed there was no one in the room who had been through the passes quite as recently as he had. In the last few weeks he had been through the Khyber to the Afghan frontier below Landi Kotal, through the Malakand to Chakdara, and through the Kohat. He was perfectly convinced—not because he knew anything about India, but because for years his life had consisted in finding out and classifying the opinions of other people—that the only way to get rid of frontier troubles was by an occupation of the frontier, and this could not be successfully carried out unless the number of roads was enormously increased. The question of a railway through the Khyber was of the most vital importance. Only on the previous day a high official of the Indian Government had told him that if he really wanted to "go for" the Government he should complain bitterly that for the last twenty years the great need had been for a railway through the Khyber. When talking to generals in the Khyber, they implored him to make every effort he possibly could to insist on the railway being carried through. When it was begun it should not be spoiled by making it a metre gauge. The broad gauge ran to Jamrud, and if the line was carried through the Khyber on a metre gauge there would be infinite trouble whenever any warlike operations had to take place. The railway was quite possible from an engineering point of view, and it was not much more costly to run a broad gauge than a metre gauge. There was no reason

why a railway should not run through the Malakand to Chakdara and by connecting those railways the turbulent tribes would be at the mercy of the British. In 1918, it was said, there were no less than 507 trans-frontier raids in the Province of Peshawar alone. As far as he could gather, the only way to stop that was the old Roman system of civilising by means of roads, and by the modern means of railways. He advocated taking the subsidies away from the tribes and giving the money to individuals in the shape of wages for building the railways. The tribes would get the same amount of money, and, instead of disloyalty, there would be an education in work which would turn the tribesmen into contented settlers The Swat Valley was almost civilised to-day through roads, irrigation, etc.

SIR GEORGE BUCHANAN, K.C I.E., M.Inst.C.E., said the Province in India he knew best, Burma—sometimes called the "Cinderella Province"—was supplied by nature with magnificent waterways—in fact, in Lower Burma they were the principal means of communication; but waterways, however good, must be backed up by roads and light railways, and there must be in addition to waterways through railway lines and roads. Further, as every engineer knew, waterways deteriorated and required supervision and maintenance. It was not, however, until 1919 that even a survey was made of the waterways, and in the matter of roads to all intents and purposes there were none worthy of the name. The British had been in Arracan and Tenasserim nearly a hundred years, and the former division with an area of 18,500 square miles possessed only 33½ miles of so-called roads. So long ago as 1886 Sir Harvey Adamson, ex-Lieutenant-Governor of Burma, then a district officer, wrote: "We have held Akyab for sixty years, during which time we have taken from the land a comparatively much heavier revenue than in other parts of Burma, and yet we may travel far and wide throughout the district without seeing indications of a single rupee ever having been spent for the improvement of the country, or the benefit of the people." In Tenasserim, with 36,000 square miles, there were until the War ten miles of metalled road, but the need of wolfram for war purposes speeded up matters, and within a year a good system of roads had been constructed in the Tavoy district, but the remainder of Tenasserim, with some of the finest rubber land in the world, and a great salt industry, remained without either roads or railways. All over Lower Burma skeleton bridges could be seen, the roads of which they at one time formed a part having disappeared, leaving the bridges as a monument to our administration. The recently issued report of a special committee which had sat for three years and went into the whole problem of communications, stated that the estimated capital expenditure to convert the existing tracks into a not very high standard of metalled road was £8,000,000, with a recurring expenditure for maintenance of a million pounds a year. No comprehensive scheme for new roads was drawn up, as such would have been a waste of time. The total mileage of railways in Burma was only 1,600 miles, and it was not too much to say that £10,000,000 could be usefully spent on profitable railway lines at the present time, in addition to a comprehensive road programme. As a result of his experience he fully subscribed to all Lord Montagu had said as to the vital necessity for adopting a comprehensive programme of road construction in India and Burma. He congratulated Sir William Joynson-Hicks on his happy experiences when travelling on the Indian railways. During the last eighteen months of the War he (Sir George Buchanan) travelled 49,000 miles on Indian railways, and his experience was quite the contrary to that of Sir William Joynson-Hicks, as he found that when in the course of a journey a train lost an hour's time, it continued losing time, and arrived at the terminus often four to six hours late.

LIEUT.-COLONEL SIR CHARLES H. BEDFORD, LL.D., D.Sc., M.D., said he had just come back from Burma, and he constantly encountered complaints with regard to the backwardness of that Province in railways and in roads. The commercial community in Burma felt strongly the neglect from which they suffered by lack of development of communications, the feeling being that Burma was a specially rich milch cow for the Government of India, who withdrew from it an undue proportion of revenue for general purposes, and that Burma was relatively starved in the matter of money for the development of railways and roads. The only fairly good road in Burma was the military road running from Rangoon to Prome. The necessity for cross roads linking up certain of the waterways was great. He hoped that the Government, hand in hand with their industrial developmental schemes, would press forward the extremely important subject of communications.

MR. H. KELWAY BAMBER, M.V.O., exhibited an interesting series of lantern slides showing the various methods of rail and road locomotion in India. He suggested that had internal combustion engines and motor cars been in as an advanced a condition ten years ago as to-day, much of the money spent on light feeder lines would have been expended on roads and motor cars. He believed that in the future this form of transport would be extensively developed, and there were no doubt many places in India where feeder roads could be constructed with very great advantage, and with satisfactory commercial results.

Sir Charles H. Armstrong said he was recently in the canal colonies of the Punjab, and had been very much struck with the excellence of the roads there round about Montgomery and Okara. In developments of that kind first-class roads should be made, so that produce might easily be brought to the stations. Also while in India recently he motored from Delhi to the Kutb Minar in the very greatest comfort. Railways in India had been passing through a very difficult time, and the rolling stock was not as it should be, and engines could not work to their full power. At present they had to use an inferior class of coal. He thought, however, that as soon as the railways could obtain renewal supplies there would be a very great improvement in the railway service in India.

Mr. T. J. Bennett, M.P., C.I.E., in proposing a vote of thanks to the author of the paper, said Lord Montagu had done a great service in calling attention to the shortcomings of the Government of India in regard to its main roads. Early in last year Parliament had been engaged in considering the Transport Bill, and the fear of many was that the Transport Minister, being a railway man, might show more affection towards the railways than the roadways; but protection was afforded against that danger by the appointment at the Ministry of a Chief of the Road Department, who was as great a man in roads as Sir Eric Geddes was in railways. From the experience of India it was possible to see a disadvantage and a danger in this country if at any time there was an obsession on the part of a Railway Minister to dominate the policy of the Ministry of Transport. The author had given some very useful suggestions as to the lines upon which a road policy in India should be carried on. He believed the arrangements under the new system of government in India contemplated that military roads should be an Imperial subject, while roads that were not of a military character should remain in charge of the Provincial Governments under a Minister. He thought it would be an advantage for the Provincial roads to be in charge of the Provincial Governments, because local influence would be brought to bear upon the administration, and when taxation had to be resorted to for improvement of the roads it would have to be done with the consent of the people themselves, who would have to pay for the work.

Colonel C. E. Yate, C.S.I., C.M.G., M.P., in seconding the motion, said one of his greatest regrets at the end of the Afghan War last April was that peace was not declared by our generals on Afghan soil at Dakka, instead of bringing the Afghan Delegation to India and wasting two months in negotiations there. It would have been far better to have said that Dakka was to remain British territory in the future, and that the railway [illegible] completed to Dakka from Jamrud. The [illegible] for road communications as well as railway communication in India was very [illegible] made last year [illegible] out the Punjab, [illegible] plainly how necessary it was [illegible] road communications [illegible] communications. He also [illegible] great necessity of planting trees [illegible] roads and of tarring the roads. Water communications were also a great necessity.

The resolution was carried unanimously.

Lord Montagu of Beaulieu, in reply, said he remembered telling the Viceroy that if he did not make good lateral roads the tribes would become more formidable in future. He had to thank the late Viceroy (Lord Hardinge), the present Viceroy (Lord Chelmsford), the late Secretary of State (Mr. Austen Chamberlain), and the present Secretary of State (Mr. Edwin Montagu), as well as Generals Barrow, Cox, and Cobb, under whom he had served, for the great help they had always given to him when he tried to tackle the question under discussion.

The meeting then terminated.

IMPORTANCE OF THE JAVA SUGAR INDUSTRY.

Java is the third largest sugar-producing country in the world, ranking next to Cuba and British India. As the last consumes practically all that it produces, Java ranks next to Cuba in sugar exports, actual production being about half of the Cuban output, and approximately three times the production of the Hawaiian Islands. Compared with the Hawaiian industry, where, it is understood, there are about fifty sugar centrals, Java has at present 186 producing mills.

It appears from a report by the United States Consul at Soerabaya that, on account of the density of population in Java, which is estimated now to be more than 30,000,000, the Government does not permit of large concessions of land, and will allow the use of any given tract of land for sugar production for only one year out of three, requiring that rice be planted for the other two years. This necessitates a rotation of crops in three-year periods, and continually reserves two-thirds of the available sugar land for the production of rice. This has been found to be a very wise provision, since, even under the present system, the consumption of rice is greater than the production in Java in normal years, so that the country is somewhat dependent on the near-by rice-producing countries for imports of the staple food supply. During last year there was, in fact, considerable discussion looking toward the further restriction by Government of sugar cultivation, in order that the local rice production might be increased. This proposal was eventually

abandoned, however, in view of the importance and value of the sugar crop at the present time of great world demand and consequent high prices.

The sugar-mills are for the most part large modern plants, although some of the labour-saving devices in common use in many other countries are not used owing to cheap and plentiful labour. There is now, however, a growing interest in labour-saving appliances and machinery, due to the increased cost of labour and a certain amount of labour trouble which seems to be prevalent to-day in Java as well as other parts of the world. Java sugar-growers are now, for the first time, coming to a realisation of their rather precarious situation in depending so completely on unskilled labour.

It would appear that the time for the introduction of labour-saving machinery is rapidly approaching, and careful and systematic efforts by manufacturers in this direction should bring results during the next few years. Most of the estates are supplied with light railways, operated with small, light wagons, but many still rely largely on bullock-carts for bringing the cane to the mills and native labour in handling it. Many estates use small wagons on the light railways, either pushed by hand or drawn by bullocks, while only a few have locomotive equipment.

The transportation of cane is especially difficult in Java, because of the fact, above mentioned, that planted areas are in small plats interspersed with plots of rice paddy, so that a plantation of 2,000 acres of cane is compelled to extend its transportation system over territory of three or four times that amount of land. Figuratively speaking, a plantation of four square miles of cane, where the longest haul would be about a mile if the mill were placed in the centre of a compact tract of that size, would require a long haul of more than two miles, if only a third or fourth of the land is in cane. Actually the difference is, in many cases, considerably greater than in the above hypothetical case, since the plats are not arranged with mathematical precision. A certain plantation, for example, of approximately 4,000 acres under cultivation, must haul the cane about eight miles from some of its more distant fields. As the plats are changed from year to year, much of the light railway must be portable.

A NOVEL SYSTEM OF AERIAL RAILWAY.

It is stated by *L'Eclaireur*, of Nice, that a novel system of aerial travel has been invented by M. Henri Coarda, a well-known French engineer. According to that journal, the plans for the construction of the first line to be constructed in the Department of the Alpes Maritimes have already been submitted to the Prefect for authorisation. The new system to be adopted consists, mainly, in establishing a fixed cable line between the two extremities. From this cable, to be supported at a suitable height above the ground by posts placed at intervals, will be hung specially constructed avions or aeroplanes, to serve as passenger cars. These, which will be quite independent of each other, will serve as the passenger cars. They will be provided with the usual screw propeller, and planes or wings, as in use for independent aeroplanes. They will be driven in the usual way by a motor at a speed of about 150 kilometres per hour (about 100 English miles).

M. Coarda proposes to construct a first and trial line from the sea-coast at Meulon to Piera Cava, a well-known summer resort, about 30 miles to the N.E. of Nice, and at 1,500 metres (4,800 feet) altitude. The total length of the proposed line from Meulon will be about 36 kilometres (22 miles), and it is estimated that the journey would occupy about twenty-five minutes.

If successful, other lines would be immediately constructed to other places in the mountains, which, owing to difficulty of transport, are little frequented by the public.

It is to be hoped that by means of such air-lines Nice and Paris will be brought within six or seven hours' journey from each other.

HONG KONG'S TRADE IN PRESERVED FRUITS.

The export of preserved fruits from Hong Kong, according to the American Consul there, generally known in the trade as "preserves," and including many Chinese delicacies such as cumquats and lichees and various combinations such as "chow chow," is showing a sharp revival with the renewal of trade to Europe; exports to the United States also have shown a marked advance. Shipments from Hong Kong classified as "preserves" to all countries in 1919 were valued at 405,183 dols., of which Great Britain is credited with 104,543 dols. and the United States with (declared value) 151,793 dols. as compared with a value of 101,778 dols. in 1917. Australia, Canada, and various parts of China took practically the whole of the balance. The American figures also include a fair amount of tinned Chinese fruits. During the first half of 1919 the United States was credited with declared exports of preserves to the value of 86,646 dols., as compared with a declared value of 36,341 dols. for the first six months of 1918. The Hong Kong statistics indicate total exports of this general class "preserves" for the first three months of 1919 amounting to a value of 275,129 dols., of which Great Britain took 195,955 dols.

As in the case of ginger and similar products from this field, the high price of sugar militates against any very great increase in the trade, not only because the sugar which is used in the manufacture of these preserves costs 11·75 dols. gold per picul (133⅓ pounds) as compared with 6·76 dols. gold a picul a year ago, but also because the actual supply of sugar on hand in Hong Kong has been limited. The result has been a hesitancy on the part of manufacturers to sell for future

deliveries until they have the necessary stock of sugar in hand. This trade in preserves is one of more importance in local trade in Hong Kong than its actual volume indicates; for the preserve factories employ a considerable number of people and their materials are grown in the vicinity of Hong Kong, so that growers depend upon this port almost entirely for their market.

OBITUARY.

FRANCIS EDWARD ROBOTHAM.—Mr. Francis Edward Robotham, who was elected a Fellow of the Royal Society of Arts last year, was drowned in a boating accident in Finland on June 24th, at the age of thirty-five. He was educated at Manor House School and the City of London School. Being ineligible for the Army on medical grounds, he assisted in preparing the Clapham portion of National Registration, and subsequently became Honorary Secretary for the Clapham South Ward Food Control Committee. He was a keen student of microscopy, especially as applied to bacteriological research, and was a Fellow of the Royal Microscopical and of the Linnean Societies.

GENERAL NOTES.

EXTINCT ANIMAL REMAINS IN SOUTH AUSTRALIA.—Some eight years ago portions of a giant Nototherium were found near Smithton, recalling the Diprotodon bones found twenty years ago in Lake Callabonna in South Australia. Now further remains in the Mowbray Swamp have been discovered. The find is a skeleton of Sir Richard Owen's "Nototherium Mitchelli," which it is contended is quite distinct from the "Nototherium Tasmanicum," referred to above. The present specimen is much mutilated upon the right side, evidently having died in shallow water, but the left side and the skull being more deeply buried have escaped the exposure that ruined the pelvis and the right limbs. From the more complete left side much valuable scientific evidence regarding the feet, hands, and other parts will be obtained. De Vis, the great Australian palæontologist, of Queensland, in 1888 claimed that the three generic races of Nototheria existed in pleistocene time. The remains they are getting out will probably clear up some points in regard to this question. It must be remembered that Professor Owen never saw all the bones of the animal he called Nototherium Mitchelli. It is of much interest to see that the arm bones which Huxley and his followers thought to belong to a small race of Diprotodons really did belong to Nototherium, as Owen always contended. The work of the excavator is very difficult. The diggers, dressed in gum boots and waterproofs, are always up to their waists in the awful mud of the old swamp that bottoms here at well over 6 ft. It is well known that Australia is one of the oldest lands on the earth, and these giant relics of bygone ages are of intense interest.

THE PEAT INDUSTRY OF DENMARK.—The Danish production of peat for the years 1916, 1917 and 1918 was respectively 280,000 tons, 1,800,000 tons and 2,250,000 tons. In 1918 the working capital invested in this industry was 58,000,000 crowns. At the average price of 40 crowns per ton, the total value of the peat produced in 1918 was 90,000,000 crowns. When it is considered that 2½ tons of peat are equal in heat value to 1 ton of coal, the peat produced in 1918 substituted imported coal to the value of 126,000,000 crowns. The future prospects of the peat industry are not considered to be very good, the principal difficulty being the poor facilities for transporting the peat from the bogs to the consuming centres. Peat played a very important part in taking the place of imported coal during the war, and it is now being used to a large extent on account of the coal shortage.

SILK RESEARCH ASSOCIATION.—The Research Association for the Silk Industry has been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. As the Association is to be registered as a non-profit-sharing company, the promoters have applied to the Board of Trade for the issue of a license under Section 20 of the Companies (Consolidation) Act of 1908. The Secretary of the Committee engaged in the establishment of this association is A. B. Ball, Esq., The Silk Association of Great Britain and Ireland, Kingsway House, Kingsway, W.C.

GERMAN PROCESS FOR MANUFACTURING ARTIFICIAL WOOL.—According to a Belgian authority, there is considerable interest in Germany in a patent recently taken out for a process for the manufacture of artificial wool. In principle, the process consists of compressing wool scraps which cannot be otherwise utilised—shreds, ends, short fibres, washing wastes, etc.—and soaking them in a viscous solution of cellulose or one of its compounds with a small percentage of glue; the product thus obtained is cut into thin sheets and strips, which can be treated after the manner of paper yarn. The Germans claim that the yarn thus obtained possesses all the properties of real wool. It is made waterproof by treating it in the process of manufacture with compounds of chromium, and later with formaldehyde and tannin, after which the product will resist the action of boiling water. The addition of glycerine gives it sufficient flexibility. This process is now being modified, writes the United States Trade Commissioner at Brussels, by the mixture with the woollen waste of a certain percentage of paper pulp and treating the product with sulphuric acid and zinc chloride. The addition of various other compounds gives it the necessary flexibility and makes it waterproof.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

CHAIRMANSHIP OF COUNCIL.

On Monday, July 12th, at their first meeting in the new session, the Council elected Mr. Alan A. Campbell Swinton, F.R.S., Chairman for the ensuing year.

COUNCIL.

On Monday, July 12th, the Council elected Lord Sanderson, G.C.B., K.C.M.G., a member of the Council and Vice-President of the Society in place of Viscount Cowdray, who was unable to serve; and Sir Philip Magnus, Bt., M.P., a member of the Council in place of Viscount Elveden, C.B., C.M.G., M.P., who was prevented by his engagements from accepting office.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION.

A meeting of the Indian Section was held on Monday, May 31st, 1920; Sir Robert W. Carlyle, K.C.S.I., C.I.E., in the chair.

The Chairman, in opening the meeting, said that the author of the paper, Mr. Albert Howard, had been the Imperial Economic Botanist to the Government of India since 1905. All that time his wife had been associated with him in his work, and she was now formally acknowledged by the Government as his colleague. Mr. Howard would deal with some of the most important lines on which agriculture in India was being run and improved. As a Member of Council of the Government of India, he (the Chairman) had been in close touch with Mr. Howard's work, and had learned to put the greatest value on his judgment, and he felt it a privilege and pleasure to have been able to remove difficulties from his path.

The paper read was—

THE IMPROVEMENT OF CROP PRODUCTION IN INDIA.

By Albert Howard, C.I.E., M.A., F.L.S.,
Imperial Economic Botanist to the Government of India.

I.—Introduction.

Agriculture is, and for many years to come must remain, India's greatest industry. In comparison with the value of the annual produce of the soil and the trade in raw materials, the remaining industries of the country are, with few exceptions, relatively unimportant.

When we examine the agricultural products themselves, it is at once evident that crops are of far greater importance than animals. The Indian cultivator is a grower of crops, and he usually regards his live stock as mere aids to cultivation and in the feeding of his family. The country does not export meat, wool or dairy products. When, therefore, the present Indian Agricultural Department, founded by Lord Curzon in 1904, began operations, the attention of its members was mainly directed to the study of the crops of the country.*

As is well known, the agricultural conditions of India and its problems are entirely different from anything to be found in the West. The investigators speedily realized that they were in a new world. The crops were seen to be raised by a multitude of small cultivators—conservative, for the most part poor and unable to command much credit. The average yield per acre was low but remarkably constant.

While the average production showed no change, the seasonal variations in yield were considerable. India was found to be a country of climatic extremes not only as regards the rainfall, but also with reference to temperature, to floods and high winds. Except in certain

* Recently, much attention is being paid to the milk supply in the towns of India, and to the improvement and feeding of the indigenous breeds of cattle.

favoured localities, the annual crop was always at the mercy of a variety of circumstances quite beyond the control of the cultivator. It was not surprising, therefore, to find him conservative in his outlook, and to discover that his leading idea in crop production was to play for safety.

The easiest line of advance in improving production lay through the plant. The problem was successfully attacked in two directions, namely, by the provision of improved varieties and by the study of the factors which influence plant growth. It will be convenient to deal with these two lines of work separately.

II.—The Improvement of Varieties.

The Indian cultivator rarely pays much attention to the seed he sows. Seed merchants in the English sense do not exist. With a few exceptions there is no attempt to keep the various varieties separate, so that mixed crops are the rule. Most of the kinds grown are low yielders of no particular quality, and with little power to respond successfully to improved soil conditions. This want of attention to the variety and the absence of high quality in the final product, all correspond closely with the general low standard of agriculture.

The field of work for the plant breeder in India was an ideal one. Nothing had been done. The country was vast, and was made up of large tracts such as the alluvium of the Indo-Gangetic Plain, the black soils of the Peninsula and the deltas of large rivers, where the general agricultural and soil conditions over large areas were far more uniform than in a country like Great Britain. The work of improving the varieties was started in 1905, and during the last fifteen years a large volume of results has been obtained. It is impossible in the limits of a single paper to do anything like justice to this work, which comprises scientific investigations on the inheritance of characters as well as others of immediate practical importance. New varieties of wheat which add every year more than £1 an acre to the profits of the cultivators now cover almost a million acres. Similar results are being obtained in the case of rice, jute, and tobacco. The crop to which most attention has been paid is cotton, and in the principal areas in which it is grown the distribution of new varieties has already affected large areas. Instead of describing this progress in detail, I propose to confine my remarks to a number of points of general interest which have arisen in the course of the work. These refer mainly to the variety and to the distribution of seed.

Some Varietal Characters.

Uniformity of Product.—Modern industry demands a uniform product. Not only must each consignment be up to sample, but the product should not change materially from year to year. In this way a reputation is established and the work of the merchant and of the manufacturer is facilitated. The mixture of varieties which goes on in the fields of the cultivators and the want of attention to the seed supply, run counter to this demand. It results in serious loss of uniformity in the produce. Further admixture often takes place after the seed has left the threshing floor. The result is that Indian produce lacks that uniformity and evenness which modern industries demand. This state of affairs renders it easy to bring about the first stage of improvement in crop production, namely, the cultivation of an even product free from admixture. Several successful schemes of seed distribution have been based on this principle. The mixed varieties in a tract are separated, grown side by side, and the most promising strain is then adopted for general distribution. As the mixed crops always contain many poor types, the yield of the pure strain is often a little greater than that of the country crops. Provided the seed distribution is effectively carried out, the local markets at once benefit by supplying to the trade a definite grade in place of a somewhat inferior mixture. A good example of such an improvement is the distribution of the wheat known as Punjab 11 in the Canal Colonies. This is the predominant constituent of one of the local mixed wheats which used to be very popular among the cultivators round Lyallpur. The mixture is now being replaced by one of its constituents to the advantage of all concerned.

Yield.—The importance of yield in any new variety cannot be over-estimated in India. The cultivator is conservative and is not prone to change either his methods of agriculture or the local varieties of crops to which he is accustomed. It is difficult to make him take an interest in questions like improved quality unless an enhanced price can be obtained at once. Every cultivator, however, can understand the meaning of a good crop and of a variety which can be relied upon to produce a yield above the average. Once this is assured, the success of any new variety is certain, and no difficulties in obtaining his co-operation need be feared. While yield is of such paramount importance in India, it must never be forgotten that the growing period of the crop is much more strictly limited than in countries like Great Britain.

Generally speaking, in England there is a fair degree of latitude at both ends of the season. In India this is not the case. For example, the sudden change from the monsoon to cold weather conditions in Northern India, and from the cold season to the hot months, impose temperature limits which restrict growth to a definite period. Thus in Bihar, the period during which wheat must be sown to ensure a full crop, is less than ten days. Early sowing is impossible, as the soil is too hot for the seedlings; late sowing means a great slowing down in growth due to the rapid fall in temperature, and the crop cannot ripen in time. More important than the time of sowing are the factors which affect the crop during the ripening period. A rapid rise in temperature takes place in March, the hot weather is ushered in with dry hot winds, and the transition from a period when wheat can ripen to one in which it merely dries up is a matter of a few days only. Once the hot winds begin, ripening ceases, the crops wither and shrivelled grain is the result. Early hot winds or a spell of hot weather may reduce the yield by half. Experience proves that a variety which ripens well within the growth period of any particular locality gives the best return over a number of years. It sometimes happens that in exceptional seasons a late, high-yielding wheat may give a crop considerably higher than that yielded by the more rapidly maturing kinds. The position is, however, reversed in average years, while in very short seasons the rapidly maturing kind gives a fair crop, and the high yielding type practically nothing beyond straw. Yield is often a pitfall for the plant breeder in India, where it is always safe to disregard the results of exceptional seasons. Many examples could be given where serious mistakes of this character have been made. Some years ago, one of the Bihar indigo planters was very much impressed by the appearance in the field of one of the late durum selections—No. 20. In spite of being warned, he obtained sufficient seed for sowing several hundred acres of his estate. The growth was magnificent, and the promise of a bumper crop seemed certain. Ripening, however, was interfered with by hot winds, and the crop was not much more than half the estimated yield. A similar experience has often been obtained with Muzaffarnagar wheat, a country mixture which does well under irrigation in the Meerut Division of the United Provinces. In certain years it also does well in Oudh and Bihar, but on the average it only produces low yields of rather shrivelled grain due to hot weather during the ripening period. It is a remarkable fact that in many parts of India some or all of the country varieties of wheat grown are on the late side. The samples at harvest time often contain a high proportion of rather thin grain, particularly in tracts like Oudh and Bundelkhand. A great improvement in yield has been obtained by introducing a wheat of shorter growth period which can use up the limited time to the best advantage, and which can produce a well-developed grain even in unfavourable years.

In this connection, another interesting aspect of yield has arisen in India, where the standard of agriculture and the general resources of the experiment stations are far in advance of those of the people. Particularly is this the case with irrigation facilities. When yielding power is studied under these favourable conditions, varieties come to the front which prove very disappointing when tried by the cultivators. One of the highest croppers of the local Punjab wheats—No. 9—is a variety which gives good yields if well cultivated and provided with sufficient water at an experiment station. Under cultivators' conditions, however, it is apt to prove disappointing, and to yield less than earlier types of lower potential yielding power. Similar experiences have been met with at Pusa. It therefore follows in India that the variety which possesses the highest potential yielding power is not necessarily the best for introduction to the cultivator. A great deal of judgment is required in selecting the most likely kinds for such a purpose. It is a safe rule to discard all types which show the least tendency to mature late or to require special treatment. For these reasons, accurate mathematical investigations to determine which of a set of varieties is the highest yielder, which may prove of great use in a country like England, are often inapplicable to Indian conditions where the results are only of academic interest.

Adaptability is essential to the successful variety. That is to say, it must do well over a wide range of conditions, and it must also respond successfully to improved cultivation. It is an obvious advantage to all concerned to distribute as few improved kinds as possible, and the number can be materially reduced if only those possessing great adaptability are finally adopted. The best indigenous varieties in India are often defective in these respects. They only do well in a very restricted area, and when the cultivation is improved they break down at once. Thus in Rohilkhand, local varieties of

sugar-cane are well suited to the primitive conditions under which they are grown, but the moment they are intensively cultivated they run to excessive vegetative growth rather than to sugar production. The same applies to the country wheats which are useless for more intensive cultivation and only produce, under these conditions, a mass of weak vegetation which is at once laid by even moderate storms. Really improved types of sugar-cane and of wheat, while doing well under ordinary treatment, will also respond successfully to better soil conditions. This question of the adaptability of a variety is really important in India, and should be applied rigorously to all new kinds. It used to be the fashion to say that an enormous number of new varieties would have to be evolved to suit the various tracts, but this idea has not been borne out by experience. Thus the variety of cigarette tobacco known as Type 28, originally evolved to suit the conditions in the Tirhoot Division of Bihar, has been found to do well in South Bihar, in Orissa, in the Central Provinces and Central India, in the United Provinces and also in Burma. Pusa 12 wheat is now doing well in South Bihar, in Oudh, in Rohilkhand, in the Province of Agra, in the Eastern Punjab, on the Canal Colonies, in Sind, the Central Provinces and also in the hill tracts of the North West. Pusa 4 is rapidly spreading in North Bihar, in the North-West Frontier Province, in Bundelkhand, in Assam, under irrigation on the black soils of the Peninsula and in many other localities where a rapidly growing variety is needed.

Like many other successful things, the improved variety is a compromise and does not depend on excellence in a single character. Such things as yielding power and adaptability represent a combination of characters which it is practically impossible to analyse on the score card principle. No one has yet given a satisfactory quantitative expression to the various units which make up yielding power. A plant breeder, working on score card principles, might easily reject a really good variety. Being a compromise, it follows that too much attention must not be paid to single characters. Rust resistance in wheat is a good case in point. Before the present Agricultural Department was started, a great deal was heard about the desirability of obtaining rust resistant wheats for India. It was thought that once these could be secured, all would be well with the wheat crop. In reality, however, this is not the case. Many rust resistant wheats have passed through my hands at Pusa which were quite useless for any purpose beyond plant breeding. The quality of rust resistance was united with so many weaknesses in other respects that the wheats were little more than curiosities. Naturally the ideal wheat will be highly rust resistant, but in practice it is better to unite with vigour, adaptability, good yielding power, good quality, and good straw, a fair degree of rust resistance, than to pay too much attention to this one point.

While single characters by themselves are generally useless, nevertheless a trivial colour character, when in combination with others, may be of great use when the seed of an improved kind has to be distributed among the cultivators. In the systematic replacement of the country crop, the Agricultural Department must be able to check the work. The replacement must be carried out according to plan, and admixture with inferior types must be easily detected. For this purpose, the improved kind must be readily recognised in the field. It is a great advantage, therefore, if it possesses some distinctive colour characteristic by which it stands out clearly from the ordinary crop. In cotton, any peculiarity in the colour or shape of the flower is important, while in wheat, chaff and straw colour are most helpful.

Quality.—While yield is usually more important than quality, nevertheless questions of quality are often worthy of attention. As is well known, yield and quality are rarely combined in one variety. High yielders often possess low quality, while varieties of the highest quality are seldom satisfactory on the question of yield. While it may not be possible to combine the highest yielding power and the highest quality in one variety, nevertheless high yield can be united with quality far above the average. This has already been done in India in a number of varieties of cotton, wheat and tobacco.

Of perhaps greater difficulty than the union of quality with yield is the satisfactory sale of good quality. Payment for yield is easy and immediate. Payment for quality is often a slow process. Take the case of cotton. Here it is much easier to produce an improved variety than to establish it successfully and to ensure a proper price to the grower for quality. First of all, the seed supply has to be organized, which is by no means a simple matter. The greatest attention has to be paid to the prevention of cross-fertilization in the field, otherwise an improved cotton will rapidly degenerate. The cultivator must also be prevented from filling

up the blanks after sowing with inferior varieties, as recently happened on a large scale in the Punjab. The greatest difficulty is the ginning, as during this process the cotton-seed passes for a time beyond the control of the grower and of the Agricultural Department. The next step is to arrange for a large compact area of the improved kind, preferably near an important market, and to help the cultivator to obtain a fair price for quality. The traders say small lots are useless to them, and that a full premium cannot be expected unless thousands of bales are available. The Agricultural Department says the best way of obtaining thousands of bales is to encourage the grower by an immediate and substantial premium. This difficulty is being partly overcome by selling the produce to the local Indian mills, but this limits competition and is not a complete solution of the difficulty of the effective sale of quality.

In the case of crops like wheat, which are largely consumed in the country, and which rarely cross-fertilize, the sale of quality is simpler than in the case of cotton. There is much more competition. The moment the new high quality Pusa wheats, now being distributed in India, appeared on the local markets, they commanded a substantial premium, which has since increased. There was keen competition to secure the wheat for food. Export buyers, who wish to secure these wheats for shipment, will find the premium already fixed. Local competition in this instance has secured payment to the cultivator for quality. Special auctions, under the *ægis* of the Agricultural Department, have been unnecessary.

The Distribution of Seed.

The absence of the seed merchant in India throws much of the work of raising and distributing improved seed on the Agricultural Department. This work is now very important, and has already grown to enormous dimensions. Much time and thought have been devoted to the problems which have arisen from time to time, the solution of which is certain to interest many workers outside India.

The Methods of Supply of Pure Seed.—It is obviously impossible, in a country the size of India, for any Government Department to grow more than a very small portion of the total amount of seed required for sowing. In replacing the existing crops by better varieties, it has been necessary to build up large organizations for seed distribution in which the people co-operate with the Department. These organizations vary according to the Province and according to the ideas of the men who have set them in motion. They are necessarily more elaborate in the case of high quality cotton (where both admixture of seed and natural cross-fertilization have to be guarded against) than they are in crops like short staple cotton and wheat. All the schemes are based on the Government seed farms, at which the first supplies of pure seed are raised.

Till recently, the difficulty has been to supply sufficient pure seed for starting and re-stocking the local centres of distribution. Large, well-managed seed farms, from 200 to 300 acres in area, are now to be seen in several places, mainly as the result of a large grant in aid by the Government of India. The Supreme Government decided, in the early years of the war, to devote the profits arising from the control of the export trade in wheat to some public purpose which would help the tracts which produced the seed. The money was given to the provincial Agricultural Departments concerned, and devoted by them largely to the provision of new seed farms. The result has been a great impetus to the important work of seed distribution. Moreover, these large seed farms serve to demonstrate, in a very effective manner, the value of an improved variety. A stretch of a hundred to a hundred and fifty acres of an obviously superior variety, true to type and well grown, never fails to impress both the administrator and the general public, and to convince them of the reality of the work in progress. The seed farms conducted directly by Government serve merely as the sources of supply of pure seed for the various local centres, where the seed is further multiplied before distribution to the actual cultivator. These local centres of seed supply are mostly managed privately or by bodies such as Co-operative Credit Societies, District Boards, or the Managers of the Court of Wards' Estates. Every possible kind of local agency has been enlisted in this work. In this way, the Agricultural Department has been able to extend its influence considerably without having to expand its organization unduly. The local notables, such as the Taluqdars of Oudh, are beginning to be interested in the movement, and several members of this body now possess large, well-managed seed farms which are proving of great value in the development of Oudh.

Systematic Replacement.—Given a large quantity of the pure seed of an improved variety, and an organization for spreading it among the people, the most effective method of using it

is an important matter. Should it be concentrated in a few areas or should operations be started from a large number of centres? Both methods have been tried, but the tendency is now towards concentration in definite areas, and towards the systematic replacement of the crop by the improved kind.

The work is being taken up village by village, and large continuous blocks of one variety can now be seen in various parts of India. This system of systematic replacement has many advantages. Supervision is relatively easy, the effect of the improved kinds on the market is soon evident, and it is less difficult for the grower to obtain an enhanced price for uniformity and quality when large quantities of the product are available. The seed supply is greatly facilitated, while in crops like cotton the harmful effects of cross-fertilization in the field and of mixing of seed at the ginneries are reduced. All these advantages assist the Agricultural Department considerably. The obvious benefit to the locality of a successful replacement soon becomes known, and helps materially when work is taken up in new centres.

Finance.—One difficulty in seed distribution, which is also beginning to affect other branches of the work of the Agricultural Department, has not yet been satisfactorily solved, and that is the best method of finance. As is well known, the ordinary activities of Government are based on the annual budget, which is sanctioned early in the year and which from the nature of things is inelastic both as regards time and as regards money. The financial year ends on March 31st, when the budget lapses and a new one begins. Such a method of finance is obviously unsuited to large schemes of seed distribution often involving credit. The difficulty has partly been met by annual Treasury advances. These, however, have to be repaid at the end of the financial year and their use involves an enormous amount of trouble and correspondence. What seems to be required is a Development Fund quite outside the Government Account rules, but subject to audit, which will permit seed distribution to be financed on ordinary business lines. Such work as this is outside the scope of ordinary Governmental activities, and requires its own system of finance and of accounts.

III.—The Factors Influencing Plant Growth.

The improvement of crop production in India involves two distinct branches of work. Better varieties are needed, and improvements in the methods of growing them have to be devised. I have already dealt with improved varieties, and will now pass on to the second point. In working out improved methods of producing a crop, the physiological aspect is the one which concerns the economic botanist. The chief physiological factors influencing growth are water, dissolved materials (often spoken of as plant food), temperature and air. If any of these factors are in defect, growth is at once affected, and the yield falls. This applies to all varieties. At the moment in India, crop production is being seriously retarded by factors which interfere with growth over large areas. Once these are removed, the yield is increased.

Already the study of the physiological aspect of crop production has led to important practical results, but much yet remains to be done in this promising field. Perhaps no country in the world offers better scope than India for such work. We have before us an old civilization, with a corresponding volume of traditional experience in the growth of crops. This has helped to crystallize and define the agriculture of the country to a much greater degree than has been possible in our modern tropical possessions, or in new countries like the United States of America. In India, things agricultural have had time to settle themselves. The great growth factors have left their impression on the characters and distribution of cultivated plants. Besides this, the range in conditions between the various parts of the country is very considerable. These circumstances greatly assist the investigator in the study of the physiology of crop production and in the deduction of some of the factors which are in operation. To anyone who can read his practice in the plant and has acquired an intimate knowledge of crops, India presents in its agriculture a number of natural experiments repeated year after year. Besides, the country is now covered with a network of experiment stations, at which any preliminary deductions can be tested in the field. A study of the wider aspects of particular crops, when grown under very different conditions, combined with direct experiments, has led to results of great importance. I propose to deal with some of those which relate to two growth factors—soil-aeration and soil temperature.

Soil-Aeration.

Defective soil-aeration is an important factor in many parts of India. In the irrigated tracts it is a constant cause of low yields. It is

responsible for the poor growth of cotton and millets on the black soils of the Peninsula in wet years when the expansion of the subsoil hinders percolation. It is also operating in the forest areas, and in regions like Bihar in the rainy season, when the rise of the rivers and of the subsoil water prevents the aeration of the roots for long periods.

The importance of soil ventilation in agriculture has not always been sufficiently emphasized in the past. While the need of free oxygen in the respiratory processes of the active cells of the roots of plants and of many of the soil organisms has long been realized, little attention has been devoted to this in agricultural research. A little consideration will show how this has arisen. Till recent years, the Agricultural Experiment Stations of the Empire have been situated in humid regions, where the rainfall is well distributed. Rain is practically a saturated solution of oxygen and is very effective in supplying this gas to the soil whenever percolation is possible. Hence in such regions, crops are not likely to suffer from poor soil-aeration to anything like the same extent as those grown in the arid regions of North-West India, where the soils are silt-like and lose their porosity when the surface is flooded with the formation of an impermeable surface crust.

I propose to deal with three cases in which progress has been obtained through the recognition of the importance of the soil-aeration factor. The first of these concerns canal irrigation as practised in North-West India.*

Irrigation. — Recent investigations have shown that soil ventilation plays a very important part in wheat growing under irrigation in India. As is well known, the soil is not solid, but consists of particles more or less loosely packed with spaces between them. These spaces are known collectively as the pore space, and are taken up by air and water. It is essential for rapid growth that this pore space should be large and that its oxygen supply should be continually renewed. If this is not arranged for, the roots of the crop and the soil organisms suffer from want of air and growth is affected. Water is also required. The best method of supplying oxygen and water is by means of rain. The rain dissolves oxygen from the atmosphere and supplies both water and oxygen to the soil at the same time in the most effective manner possible. When, however, we push our cultivation into the desert and attempt to make up for the want of rainfall by surface irrigation, a difficulty at once arises. Flood irrigation, by producing a more or less impermeable surface crust and by reducing the volume of the pore space, seriously interferes with aeration. Irrigation supplies the water but it tends to deprive the soil of air. Obviously the solution of this difficulty is to arrive at a working compromise between the needs of the soil for water and for air, and to devise a method of applying irrigation water which interferes as little as possible with the aeration of the soil. A large number of experiments on this point were carried out, of which a short account will now be given. The first experiments were designed to find out what kind of crop could be grown without any watering at all after sowing. These were carried out at Quetta, and the land was watered once only before sowing. The results are given in Table 1:—

TABLE 1.

YIELD OF WHEAT AT QUETTA WITH A SINGLE IRRIGATION.

Season	Area in Acres	Yield of Grain per Acre	
		m.	s.
1912–13	3·00	18	30
1914–15	2·85	16	28
	Average	17	29

One Maund = 40 Seers = 82·27 lb.

The next step was to compare the crop grown on one watering after sowing with that obtained when three waterings were given. The figures are given in Table 2 (see p. 562).

These results showed that after the first irrigation no further advantage was obtained by giving more water. On the other hand, harm was done by interfering with the air supply by the formation of a thick surface crust, and the

* It was observed some years ago that in areas like the Canal Colonies of the Punjab and in the Quetta Valley, where wheat is irrigated several times, the crop ripens much more slowly, that there is far less development of chaff and straw colour with thinner grain than when the plant is grown on natural moisture, and where the porosity of the soil is good. These differences were found to be due to the different conditions of soil ventilation in the two cases.

TABLE 2.

THE INTRODUCTION OF A NEW LIMITING FACTOR AFTER IRRIGATION.

Number of Waterings	Area in Acres	Total Weight of Produce	Total Weight of Grain		Yield of Grain per Acre		Percentage Reduction
		lb.	m.	s.	m.	s.	
One . . .	3·99	10,367	52	6	13	2	0
Three . . .	2·65	6,620	25	15	9	23	26

destruction of the porosity of the soil. Similar results were obtained in the Punjab (Table 3), in Sind (Table 4), and in the United Provinces (Table 5 and Plate I.).

A consideration of all these results indicates that over the canal irrigated areas of North-West India, a vast volume of water is annually poured on to the land to no purpose. At a

PLATE I.—PUSA 12 GROWN WITH ONE WATERING AT SHAHJAHANPUR.
Area 3·4 acres; yield 36·5 maunds per acre.

TABLE 3.

RESULTS OF WATER-SAVING EXPERIMENTS IN WHEAT (PUSA 12) AT GUNGAPUR, HARIPUR, AND SARGODHA, 1916–17.

Station	Number of Irrigations including the Preliminary Watering	Yield per Acre in Maunds and Seers		Average Yield per Acre	
		Grain	Straw	Grain	Straw
		m. s.	m. s.	m. s.	m. s.
Gungapur	One	12 19½	20 10	9 34	21 17
Haripur	,,	8 31	19 14		
Sargodha	,,	8 12½	25 27½		
Gungapur	Two	18 0	25 8	16 11	25 5
Haripur	,,	15 21	23 16		
Sargodha	,,	15 12½	26 32½		
Gungapur	Three	14 25	18 0	15 11	22 2
Haripur	,,	16 8	26 4		

TABLE 4.

WATER-SAVING RESULTS OBTAINED AT MIRPURKHAS, 1916–17.

Variety	Area in Acres	Yield of Grain in lb. per Acre		Remarks
		One Watering after Sowing	No Watering after Sowing	
Pusa 12	The comparisons were made on half plots measuring 1 to 1½ acres per plot	1,333	1,172	Soil somewhat stiff
Pissi		2,048	1,533	
Pusa 12		1,116	970	Light, free working soil
"		1,600	1,680	
"		1,418	2,062	
"		1,718	1,633	
"		1,067	1,333	
	Average . .	1,471	1,483	

TABLE 5.

YIELDS OBTAINED WITH PUSA 12 AT SHAHJAHANPUR WITH ONE IRRIGATION, 1918–19.

Previous Crop	Area in Acres	Total Yield of Grain in Maunds	Yield per Acre in Maunds
Sugar-cane in trenches	3·4	124	36·5
Sugar-cane mostly on the flat, a little in trenches	7·4	233	31·5
Total . . .	10·8	357	Average 33·1

comparatively early stage in irrigation, the aeration of the soil is interrupted, after which any further addition of water does not affect the yield. Not only is the water wasted, but the natural fertility of the soil is lowered, as is seen by the gradual falling off in yield on new canal areas, and by the increase in the area of alkali lands. The remedy appears to lie in a change in irrigation policy and the gradual introduction of a system of charging for the water by volume rather than by the area irrigated. This will lead to much less water being used. Such a radical change would require time. The consent of the cultivator on existing canals would also have to be obtained before the present system could be altered. There seems, however, no reason why payment by volume could not be applied to all new canals. It would lead to a great saving of water, to an enormous increase in revenue, and it would help to preserve the natural fertility of the soil.

Development of Waste Lands.—The second practical application of soil-aeration concerns the utilisation of some of the uncultivated areas of the country. The publication of the earlier results on the influence of soil-aeration on growth naturally attracted attention to the value of soil porosity and to soils which possessed good drainage. If soil-aeration is such an important growth factor, it would follow that soils possessing great porosity would often prove to be of the greatest value. Clouston, working in the Central Provinces, was the first to make any practical use of these ideas in India. In this Province, large areas of poor laterite soils occur which were considered below the margin of cultivation. They produced, for the most part, a thin growth of grass in the rains with an occasional millet crop. Although exceedingly poor in the ordinary sense, these soils possess excellent porosity and a texture which is unaffected by irrigation. By the addition of organic matter and by providing irrigation facilities, these useless areas have been transformed into garden land of the highest quality. Crops of over forty tons of stripped cane to the acre have been grown, as well as heavy yields of cotton, ground nuts, indigo seed and fodder (Plate II.). In all cases, the crops grown on these poor *bhata* soils were far heavier than those produced by the richer black soils in the neighbourhood, which were, however, much heavier and far less permeable. Not only was the yield greater, but there was a marked improvement in quality, and what is more striking, an entire absence of disease. These open permeable soils, by promoting aeration and nitrification, stimulated healthy

FIG. 1.—SUGAR-CANE ON BHATA.

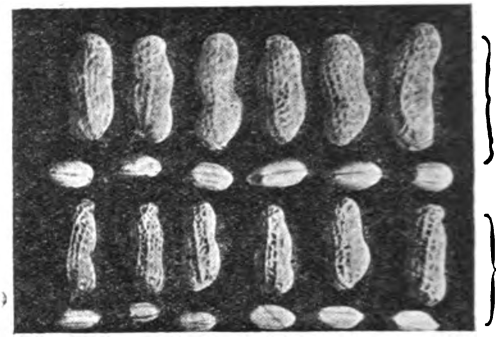

FIG. 2.—GROUND NUT GROWN ON (*a*) BHATA, (*b*) BLACK SOIL.

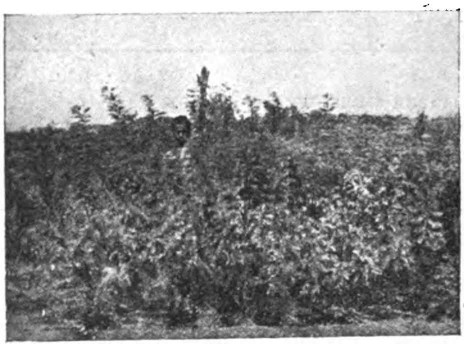

FIG. 3.—INDIGO ON BHATA.

FIG. 4.—INDIGO ON BLACK SOIL.

PLATE II.—THE CROPS GROWN ON BHATA SOILS.

root development, which in turn led to increased yields. The facts that the quality improved and that the crops grown were free from disease, indicate new lines of work on the factors on which quality depends, and on the connection between soil-aeration and disease resistance.

(*To be continued.*)

CHROME ORE DEPOSITS IN ASIA MINOR.

It has been said that Asia Minor is very rich in poor mines. The country is indeed rich in the number of its mineral deposits, but it must be remembered that the field has never been thoroughly and scientifically surveyed so as to justify a verdict in regard to whether these deposits are rich or poor.

Chrome ore deposits are to be found in Asia Minor among the eruptive rocks of serpentine formation. The four most important districts where chrome mining has been more or less developed are the Provinces of Smyrna, Brúsa, Adana, and Konia. The working of chrome mines in the Province of Smyrna was started some twenty years ago.

Among the forty chrome mines for which firmans (concessions) have been granted, only eighteen have been worked. Twenty other research permits have been issued. Most of these mines are worked in a primitive way and modern methods not having been introduced, it would be difficult to ascertain the real chrome resources of the country. Specimens of chrome ore taken from deposits in the different districts in Asia Minor proved to be rich in chromic oxide ($Cr_2 O_3$), the percentage varying between forty and fifty-five. The maximum annual production of chrome mines in Turkey amounted to 30,000 tons before the war.

Besides the lack of modern mining processes, the very inferior state of roads and communications has been another drawback to the progress of these enterprises. There are a great many mines which have not been worked, on account of their being distant from a sea-port or a railway line, and about which little, if any, information is available. According to an Italian mining engineer of thirty years' experience in Turkey, the geological structure of the Erzerum and Erzindjan regions being partly of serpentine formation, chrome deposits might well be discovered in these provinces; investigations have not been made so far, because of the comparative inaccessibility of these regions from seaports or railways. The insecurity in the interior and the reluctance of mine-owners to invest money have constituted additional impediments to the progress of mining enterprises. Moreover, the laws of the country concerning mines do not promise proper advantages

or security to holders of concessions. Consequently, foreign capital has not been forthcoming.

According to a report by the United States Consul-General at Constantinople, the chrome-producing districts of Turkish Asia Minor may be classed in four zones, according to location, as follows:—

Brusa zone.—Chrome ore is found in this zone in the Sanjak of Kutakia, near Tavshanli, mining district "Dagh-Arde"; in the Sanjak of Brusa, near Harmandjik, at 31 miles from Adranos, and also at 15½ miles from Adranos; and in the Angora Province, near Mihalidj, 3 miles from Eski-Chehir-Angora railway.

Smyrna zone.—There are chrome ore deposits in the Sanjak of Menteche, at a distance of 6½ miles from Makri; also in localities situated 23 miles south-east of Moughla, and 16 miles from the Aidini-Diner railway, near Denizli, respectively.

Adana zone.—Ore is found in the Sanjak of Adana at a distance of 23 miles from the town of Adana; in the Sanjak of Mersina near Elvanli; and in the Sanjak of Djebel-Bereket, Kaza of Yarpouz, at a distance of 16 miles north-east and 9 miles south-east of Yarpouz, near the Bagdad Railway.

Konia zone.—There are two mines in the Sanjak of Reke, Adalia, one at a distance of 6 miles, and another at a distance of 25 miles from the sea. The Sanjak of Konia has one mine; and ore is found also in the Sanjak of Hamidabad, at a distance of 16 miles north of Sparta, and on a highway leading to Dinar, which is a terminal station of the Aidini-Dinar railway.

Chrome Mines in the Province of Brusa.

The physical character of Brusa Province, its climate, the structure of the rock, its water supplies, and forests, are favourable for mining operations, or at least present no special difficulties. The annual output of the mines varies from 10,000 to 15,000 tons, and the ore is of a high grade. Research work in this Province has shown that there are more than 200,000 tons of ore available.

Mine of Dagh-Ardi.—This mine is situated in the district of Simay, near the village of Dagh-Ardi, at a distance of 37 miles from the Kutahia railway station, and 56 miles from Guemleik (near Ismid Harbour). It consists of two chrome ore deposits parallel to each other and inclined to the horizontal at an angle of 20°. They are a mass of formation of a thickness of 33 to 50 feet and of a grade varying between 44 and 52 per cent. After the process of reducing the serpentine to the maximum allowable percentage of 3 per cent., the grade of the ore could reach 55 per cent.; a mechanical treatment of the ore would raise its grade to 58 per cent. The extraction of chrome ore from the mine is attended with some difficulties; deep inclined and vertical shafts must be used in order to attack the mass of rock at low strata.

Scarcity of labour is at present a serious drawback to the remunerative working of this ore; wages also are very high. Mine operators suggest the transfer to mining districts of groups of workmen from China and Japan. During the war the Dagh-Ardi mine was managed by a German firm and the ore was sent to Germany. This firm established transport facilities by an aerial railway 14 miles long.

Besides the two deposits mentioned there is a third one called Kervan. The grade of this ore is 33 per cent. It can be used after a thorough and proportional mixing with high-grade ores and a mechanical treatment in the washing plant.

Mine of Dombay Olduyi-Deressi.—This mine is at a distance of 2½ miles from the Dagh-Ardi mine. It is of mass formation, its grade being from 45 to 48 per cent. Transport of the ore is facilitated by the aerial railway, which crosses this mine. These deposits have not yet been worked, only research work having been carried out.

Terzi-Pounar Mine.—Situated at a distance of 6 miles from the Dagh-Ardi, and located on a wagon road. Its grade is from 50 to 52 per cent. Prospecting has been undertaken, but no real work has been inaugurated.

Assarlik Mine.—Situated at a distance of 4 miles from the Dagh-Ardi, and quite near the wagon road. Its grade is 48 per cent. Only prospecting has been done so far.

The three mines mentioned above have to be worked in conjunction with the Dagh-Ardi mines.

Karadja Keny Mine.—Situated near Karadja-Keny, at a distance of 22 miles from Kutahia; it is of vein formation and perpendicular bearing. The grade of the ore is 48 to 50 per cent. The mine has not been seriously worked. It belongs to Turks. The ore is transported to Kutahia.

Karli-Yer Mine.—This mine is situated at a distance of 59 miles from the Kutahia station. The chaussée road extends from this station to Tavshanli, which is 19 miles distant from the mine. The grade of the output has always been on an average of 55 per cent. The total production for approximately 30 years has been 130,000 tons. This mine can produce 4,000 to 5,000 tons of 55 per cent. graded chrome annually. Its approximate future production is estimated at 100,000 tons. There are forests and water supplies in the neighbourhood of this mine, and the climate is healthful. The mine now belongs to Krupp.

Abandoned Mines.—Near Harmandjik, at a distance of 7 miles from the Dagh-Ardi mine, there exist three chrome mines. They were worked by Krupps during the war and have an

uncertain status at present. The Kozloudja mine, one of the three, is situated at a distance of 3 miles from the Dagh-Ardi mine. It is of vein formation of 48 to 52 per cent. grade; the inclination of the seams is 45 degrees. The mine is exploited by underground works. A branch line of the aerial railway of the Dagh-Ardi mine will facilitate the transport of the ore. The Ardiranlar mine, situated at a distance of 7 miles from Dagh-Ardi, has yielded no great quantities up to the present. However, the production may be accelerated after serious research work. The mine is a mass of formation, graded 48 to 52 per cent. The ore is transported to Ghemleik, the nearest harbour. The ores of the Miranlar mine, situated 10 miles from Dagh-Ardi, are also transported to Ghemleik. This mine is in mass formation.

Other Chromic Deposits.—Between the Karadja-Keny mines and the Kutahia station four or five small chrome deposits of vein formation exist, graded 48 to 50 per cent. Prospecting should be undertaken and the quantity obtainable ascertained before beginning any enterprise.

Rich Deposits in the Province of Smyrna.

At one time the working of the chrome ore deposits of the Smyrna Province was carried on extensively, and proved to be highly remunerative. For a long period this Province supplied almost the entire requirements of the world in this mineral. The Smyrna ore contains from 40 to 55 per cent. chromic oxide. The annual production in chrome ore of the Vilayet of Smyrna varied between 7,000 and 15,000 tons. If the mines were properly and economically worked they night be made to produce from 50,000 to 60,000 tons per annum; but under present conditions it would not be possible to transport more than 15,000 to 20,000 tons. The lack of transport facilities within the Province also compelled mine owners to put a limit to their activity, as the charges incurred would not allow them to compete with ores of New Caledonia and Rhodesia. Construction of light railways may offer facilities for future development. In spite of the present inactivity, which may continue for a certain time in consequence of the high cost of labour and other difficulties, it is almost sure, says the United States Consul-General, that very important mining operations will be undertaken in this Province in the near future.

Kemikli Mine.—This mine is situated in the Kaza of Makri (Sanjak of Menteche) at a distance of 9 miles from the sea and 12 miles from the town of Makri. It consists of two distinct deposits—the Kesser-Ali and the Tumbachi. The Kesser-Ali deposit is formed of two pear-shaped masses lying in inverse directions; the grade is of 48 to 50 per cent. This deposit is located at the top of a hill; the ores extracted are conveyed to the Kizil-Dere River by shoots and are transported in carts to the washing plant at Imbachi. The other deposit of this mine consists of a vein from 6 to 13 feet thick, of vertical direction, and of a grade of 42 to 45 per cent. The work is carried on by shafts. Ore obtained at this mine is transported by caravans to Ichalish-Iskelessi, a small pier, whence it is taken by sailing boats to Mem-Pacha, on the opposite shore, to be shipped.

Katrandjik Mine.—This mine, situated near the seashore, consists of weak seams containing ore graded 40 to 42 per cent. Thus far it has not proved to be of importance.

Kodjek Ali Pasha Mine.—This mine is situated in the interior of Kodjek, Kaza of Yuksek Koumou, at a distance of 50 to 62 miles from the sea. It consists of seams 9 to 10 feet thick, the grade of the ore being 45 to 50 per cent. and the inclination 45 degrees. A great quantity of ore is available from this mine, which has not been worked for 20 years on account of the owner's reluctance to invest capital and to engage an engineer. The roads which lead to the seashore are in a very poor state.

The Hadji Nicola Mines.—Hadji Nicola owns many mines at a distance of 2 to 8 hours from the sea. The grade of the ore is from 40 to 48 per cent. and the work is carried on by quarrying as well as underground systems.

Patterson Mines.—These are from 4 to 12 miles distant from the sea and consist of very rich seams graded 40 to 52 per cent. Part of these concessions have been annulled and given to a certain Arif Bey, but Messrs. Patterson are taking the necessary steps for the restoration of the mines to their rightful owners.

Hadji Mehmed Mine.—This mine is quite near the locality of Makri, at a small distance from the sea. It consists of seams 6 to 7 feet thick with an inclination of 45 degrees and a grade of 46 to 50 per cent. It is not possible to give an idea of the real production of this mine as it has never been worked in a proper manner.

Besides the above-mentioned mines, there are other less important ones belonging to French, Greek or Turkish firms. No definite opinion can be expressed as to their real value, since they have been worked in the past with very primitive means. The grade of the ore obtained is from 42 to 48 per cent.

Chrome Mines in the Provinces of Adana and Konia.

In the neighbourhood of Mersia, near the village Elvanli, there are several mines of chrome which contain 50 to 51 per cent. of chromic oxide. As regards transport facilities, these mines are well situated. The ore is taken by mules to Toumouk, near Mersina, where there is a small pier to facilitate direct loading on steamers. The average annual production of

these mines can be estimated at 1,000 tons. This ore was exported to France and Germany. The other chrome mines of this Province are at present of no importance, as they have been only superficially explored. The lack of a port, of labour, and of roads are the three stumbling-blocks to the further development of the chrome deposits in this Province.

The chrome resources of the Province of Konia appear inadequate to allow further development. The average annual output of the chrome mine situated near Adalia is about 1,000 tons.

Mining Methods—Transport Difficulties.

In general, chrome is extracted by the quarrying system ; but galleries are resorted to, as well as inclined and vertical shafts, either to follow the eruptive vein or to attack the mass of rock beneath the surface stratum when the latter has been impoverished below the limit of profitable production. The usual method of extracting the mineral is the most primitive ; the tools used are limited to the pick and shovel, and when it is necessary to remove hard rock, which may be encountered in the drifts, the work is done with the hand drill and sledge hammer, while the blasting is done with ordinary coarse black gunpowder. There are no mechanical or compressed air drills in use in any part of Asia Minor.

The only transport available, in general, from the mines to the seashore or the railway station is that afforded by camels, mules, or donkeys. No properly built roads are maintained which are available for the beasts of burden ; they must carry their loads over the footpaths and tracks which meander down the mountain sides, and practically double the distance to be traversed. It would not be a difficult matter in the opinion of the United States Consul-General, to link up all the best mines by a common aerial cableway, like the one at Dagh-Ardi. This would very greatly simplify matters and be of enormous advantage from every point of view ; it would probably reduce the cost of transport 70 to 75 per cent. If an aerial ropeway were established it would be an easy matter to extend it later on to other valuable deposits farther inland, which have never yet been worked because the cost of transport exceeds the value of the ore.

Makri, from whence most of the ore is shipped, is safe and protected as a port ; but the greater part of the water is shallow, and it is only in the south-west part of the bay of Makri that the depth offers a good anchorage. Shipments are, therefore, made on small lighters carrying from 10 to 15 tons, which lighters have to be towed by a steamer from the port of Makri to the place of shipment at Ikinjik, which is only an open roadstead.

EMPIRE TIMBER EXHIBITION.

The Department of Overseas Trade is to be congratulated on promoting the exhibition of timber grown within the Empire which was opened at the Holland Park Skating Rink on July 5th and closes on the 17th. To many people the wide range of these timbers will come as a surprise. A large number are hardly known in the United Kingdom; but even a brief study of the exhibition will satisfy one that there is scarcely a purpose to which timber can be put for which the Empire does not furnish a suitable tree.

Practically every timber-growing country in the Empire is represented either by an official exhibit or a private firm, or both. The Dominions of Canada, New Zealand and Newfoundland, the Indian Empire, the Governments of Western Australia, New South Wales, Tasmania, Union of South Africa, the Administration of British Honduras, British Guiana, Ceylon, Gold Coast, Trinidad, Fiji, Nigeria, and East Africa Protectorate are all exhibiting.

Specimens are shown both in the rough and in the finished state, polished and unpolished—everything from the sawn log to the carved panel, from a lead pencil in cedar to a railway carriage in teak. A feature of the Western Australian exhibit is a panelled room and furniture made of jarrah (Western Australian mahogany or everlasting wood). The extraordinary durability of this wood is exemplified by various posts and rafters which show little sign of deterioration after periods of sixty years in the ground or roof as the case may be.

A particularly attractive section of the exhibition is that devoted to the timbers of India. Messrs. W. W. Howard Bros. & Co., agents for the Government of India, have been at great pains to show the practical possibilities of several unfamiliar timbers. In particular, attention should be called to the parquet floor and staircase of silver-grey wood, which has a delicate grey colour and a satin-like lustre; and still more to the billiard-room, which is panelled in laurel wood. This wood is of a golden to greyish-brown colour, with deep streaks and markings of a dark umber shade, and it has a bright metallic sheen on the surface when planed and polished. It is undoubtedly a very beautiful wood, and suitable for the finest decorative work. As it can be obtained in large sizes it is admirably adapted for panelling. Another attractive timber which is seen here to great advantage is Andaman padauk. This varies in colour from pale cherry to crimson and vermilion, and is generally streaked with darker shades which sometimes become a deep black. The texture is fine and hard, and the wood is extremely strong and durable. A railway coach built at the Great Eastern Railway Company's works is on view. It contains first- and third-class carriages decorated throughout in silver greywood and padauk respectively.

The exhibition should have important results for the home timber trade in making known the

resources of the Empire, and it is to be hoped that it will lead to the development of new sources of supply, the extension of established ones, and the study of a world-wide range of timbers.

NOTES ON BOOKS.

THE EVOLUTION OF BRITISH MEASURES. By Howard Wall. London: Talbot & Co.

This little book contains a good deal of interesting and curious information about the origin of British measures of length and the establishment of the British standards. Besides the essay, which gives a title to the book, it includes several articles on the Metric System, Foreign and Classical Measurements, etc., and an account of Dean, who popularised the use of measuring tapes and established a business for their manufacture in 1818. This business is still successfully carried on by the author of the book, Mr. Howard Wall. That Dean was not actually the first to produce measuring tapes is shown by a reference in the Society's *Transactions* for 1805 (vol. xxiii. p. 119) to such tapes by a writer who describes how he used one marked with inches on one side and feet on the other, for measuring the growth of trees. Such tapes were, he said, made by "Mr. Cary, optician, in the Strand." The mere fact that such a description should be given shows that the tapes were not generally known or largely employed. It seems a little remarkable that such a simple and useful device should not be able to have an earlier date assigned to it. It is possible that flexible tapes were occasionally used before this time, but it appears certain that they were not generally known or employed until Dean started their manufacture. They then came rapidly into use, and are now, of course, of universal application. Probably the latest development, and that is not very recent, is the flexible steel tape which forms such a convenient pocket measure.

Those who are interested in the subject of measurement may be referred to the excellent paper on the Metric System read before the Society in 1906 (*Journal*, vol. lv. p. 50) by the late Sir Charles Watson. It contains a very complete history of the origin of the French metre.

GENERAL NOTES.

THE FAR EASTERN MATCH TRADE.—At one time, says the *Colonial Journal*, the match trade in the Far East was largely in the hands of Swedish exporters, though a small portion of the supplies came from the United Kingdom. In the early nineties Japan took up the manufacture of matches for export, and in a very few years established such an ascendancy that British matches disappeared from the Eastern market and the Swedes were almost in similar case. Japan has at present a virtual monopoly. A British company has, however, been formed in Kuala Lumpur, the capital of the Federated Malay States, with the object of founding a match factory in the neighbourhood. Tests have been made of woods found in the forests of the Malay Peninsula, and it has been ascertained that suitable supplies can be secured for the manufacture of matches. Machinery has been ordered from England, and British Malaya will be given a new industry which promises to become one of considerable importance.

CUTLERY RESEARCH ASSOCIATION.—The [illegible] Association for the Cutlery Industry [illegible] approved by the Department of Scientific and Industrial Research, as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The Secretary of the Committee engaged in the establishment of this association is W. H. Bolton, Esq., P.O. Box 49, Sheffield.

THE FALKLAND ISLANDS.—A very remarkable case of trade development is shown by the statistics of the Falkland Islands. In 1908, according to the *Colonial Journal*, the imports were of the value of £73,062, the exports £189,972. In 191[illegible] the figures were £939,937 and £2,054,286, although [illegible] shipping was so scarce that only six vessels [illegible] the colony. The products are practically limited to wool and whale oil, and it is to the rise of the latter industry that the increase is mainly due.

HONG KONG CAMPHOR TRADE.—The shortage in the supplies of camphor, according to the Consul-General at Hong Kong, due to the much reduced output of Formosa (Taiwan) and the greatly increased demand during 1919, has resulted in a boom in the trade in Hong Kong. Exports of camphor from Hong Kong to the United States in the earlier months of 1919 were too small to be separately noted in the trade returns. The total exports from the colony for the first quarter of the year amounted to only 54,810 dols., at normal sterling exchange; the value in the second quarter rose to 233,954 dols. In the first quarter nearly the whole of the exports went to India, the Straits Settlements taking about 10 per cent. of the total. In the second quarter India continued to take some of the output, but the United States commenced to draw upon the South China stocks, taking exports to the value of 181,550 dols. Since then the export of the gum to the United States has steadily increased, the value of such exports for July reaching 176,900 dols.; those for August being valued at 208,641 dols., those for September at 360,641 dols., and those for October at 606,940 dols. Thus the total exports of gum camphor to the United States during the first ten months of the year amounted to 1,534,672 dols. The comparatively favourable price of the Hong Kong gum accounts in part for the strong demand.

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FRIDAY, JULY 23, 1920.

***All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.* (2)**

NOTICES.

COLONIAL SECTION.

A meeting of the Colonial Section Committee was held on Friday, July 16th. Present:—

Lord Blyth (Chairman of the Section); A. H. Ashbolt; Lieut.-Col. Sir Charles H. Bedford, LL.D., D.Sc., M.D.; Byron Brenan, C.M.G.; R. E. Brounger; Hon. Sir John A. Cockburn, K.C.M.G.; and W. L. Griffith, with S. Digby, C.I.E. (Secretary of the Indian and Colonial Sections).

PRICE OF THE JOURNAL TO NON-FELLOWS.

In consequence of the enormously increased cost of printing, paper, etc., the Council have found it necessary to raise the price of the *Journal* to non-Fellows of the Society to One Shilling.

PROCEEDINGS OF THE SOCIETY.

INDIAN SECTION..

THE IMPROVEMENT OF CROP PRODUCTION IN INDIA.

By Albert Howard, C.I.E., M.A., F.L.S.,

Imperial Economic Botanist to the Government of India.

(*Continued from page* 564.)

Drainage.—The third application of the soil-aeration factor relates to inadequate drainage. The essence of drainage from the plant's point of view is not the removal of water, but the maintenance of the oxygen supply of the soil water. In the case of ordinary crops like wheat, all that is necessary to bring this about is an adequate gaseous exchange between the atmosphere and the pore spaces. In water culture, of which rice is perhaps the best agricultural example, it is essential that there should be a very slow movement of oxygenated water round the feeding roots. Over large areas of India nourished by the monsoon, imperfect drainage bars progress. In the plains of India, defective surface drainage arises from two causes. In the first place, when the soils are on the stiff side, local surface accumulations of rain water rapidly lower the fertility. In the second place, the subsoil water often rises to such an extent, at a time when the flow of the rivers is impeded, that little or no general drainage is possible over large tracts. These two aspects of the subject will be considered separately.

Surface water-logging is very common in India during the rains. Any holding up of the surface drainage by irrigation channels, by embankments of various kinds, or by any slight concavity of the fields due to the misuse of iron ploughs, invariably leads to poor, weak growth, which exhibits all the characteristics of nitrogen starvation. That the loss of fertility is largely due to de-nitrification is shown by the results of an experiment carried out at Pusa in 1910. In that year, a plot of heavy land was purposely water-logged during the month of September in order to compare its behaviour with normally managed land on either side. Across the middle of the plots, a strip was manured with four cwt. of nitrate of soda to the acre just before sowing the wheat. The results are given in Fig. 1, from which it will be seen that the effect of a month's water-logging was to reduce the yield of wheat by about sixteen bushels to the acre.

Normal cultivation.	Water-logged during September.	Normal cultivation.
34·45	15·55	29·14
Shaded area [illegible] with 4 cwt. Nitrate of Soda per acre		
35·92	25·17	26·53
34·45	15·55	29·14

Fig. 1.—The Result of Water-logging Wheat Land at Pusa in 1910.

The numbers in the plan are bushels per acre.

De-nitrification is not the only consequence of surface water-logging. The physical texture of the soil is profoundly affected, and when the land dries it is difficult to obtain the ideal crumb structure. The clods do not readily break down under the beam and the soil is gummy to the feel. Colloidal substances appear to be formed under these anærobic conditions which not only hinder the formation of a good tilth, but also prevent percolation.

The remedy for surface water-logging is better drainage. A method of surface drainage has been worked out at Pusa (Plate III.) which has led to improvements in fertility and in the ease of cultivation which are almost past belief.

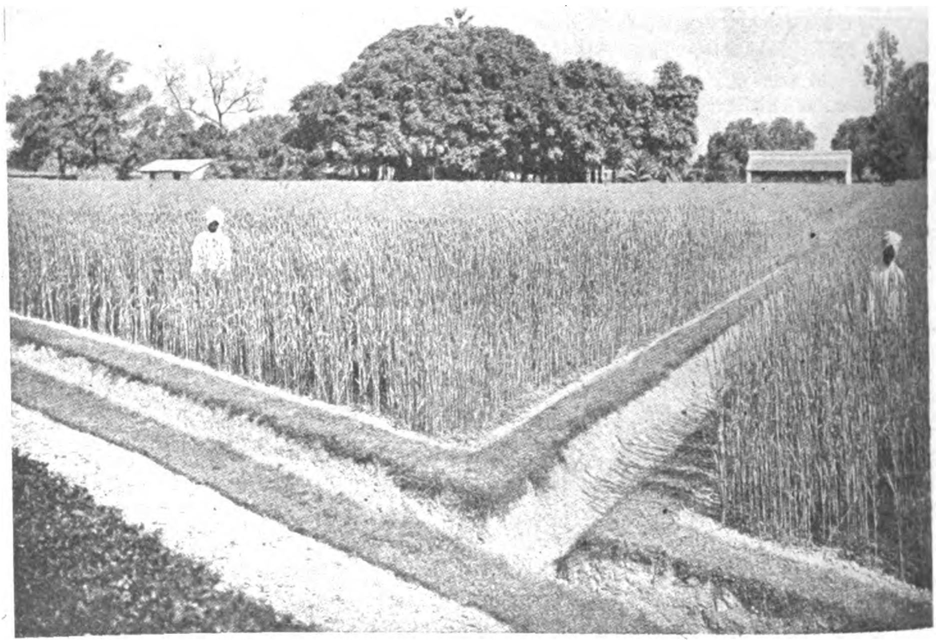

PLATE III.—SURFACE DRAINAGE AT PUSA.

This method consists in dividing up the area to be drained into units not more than four or five acres in extent, separated by trenches. These trenches are about four feet wide and two feet deep, with sloping sides and grass borders. The run-off passes over these grass borders and is led away to low-lying rice areas, while most of the fine silt is retained on the field. By this device, each field has to deal with its own rainfall only and the run-off is strictly controlled.

The Botanical Area at Pusa has been transformed by improving the surface drainage. The yields have increased, the plots produce even crops, and the tilth of the stiffer areas, which was formerly poor, is now greatly improved.* Several of the indigo estates in Bihar have adopted this system, which the surrounding cultivators are now copying.

The prevention of drainage during the rains occurs in the plains of India towards the delta of the Ganges after the flow of the rivers is checked by the inundation of Lower Bengal. The rivers overflow and the low-lying areas go under water. The rise in the level of the rivers is followed by a rise in the water level of the wells. These movements of the river levels and of the general ground-water are illustrated in Plate IV. The curves are typical of the subsoil water conditions of North Bihar during the rains. These ground water and river level curves have proved to be of particular interest

* The experience obtained in the Botanical Area at Pusa during the last fifteen years throws considerable light on the nitrogen problem in India. Surface drainage, by checking erosion and by reducing de-nitrification in the rains, has had the effect of increasing the fertility with a comparatively small expenditure of organic matter. For example, Plot 10 has, during the last fifteen years, produced thirteen heavy cereal and two good pulse crops, while the manurial treatment has consisted only of three crops of green manure and a single dressing of castor cake at the rate of half a ton to the acre. The land has improved under the treatment, and in 1919 gave a record crop of wheat of over forty bushels to the acre. Similar experience has been obtained at Quetta, and on several of the farms in the United Provinces. These results suggest that nitrogen fixation is much greater in the plains of India than is commonly supposed.

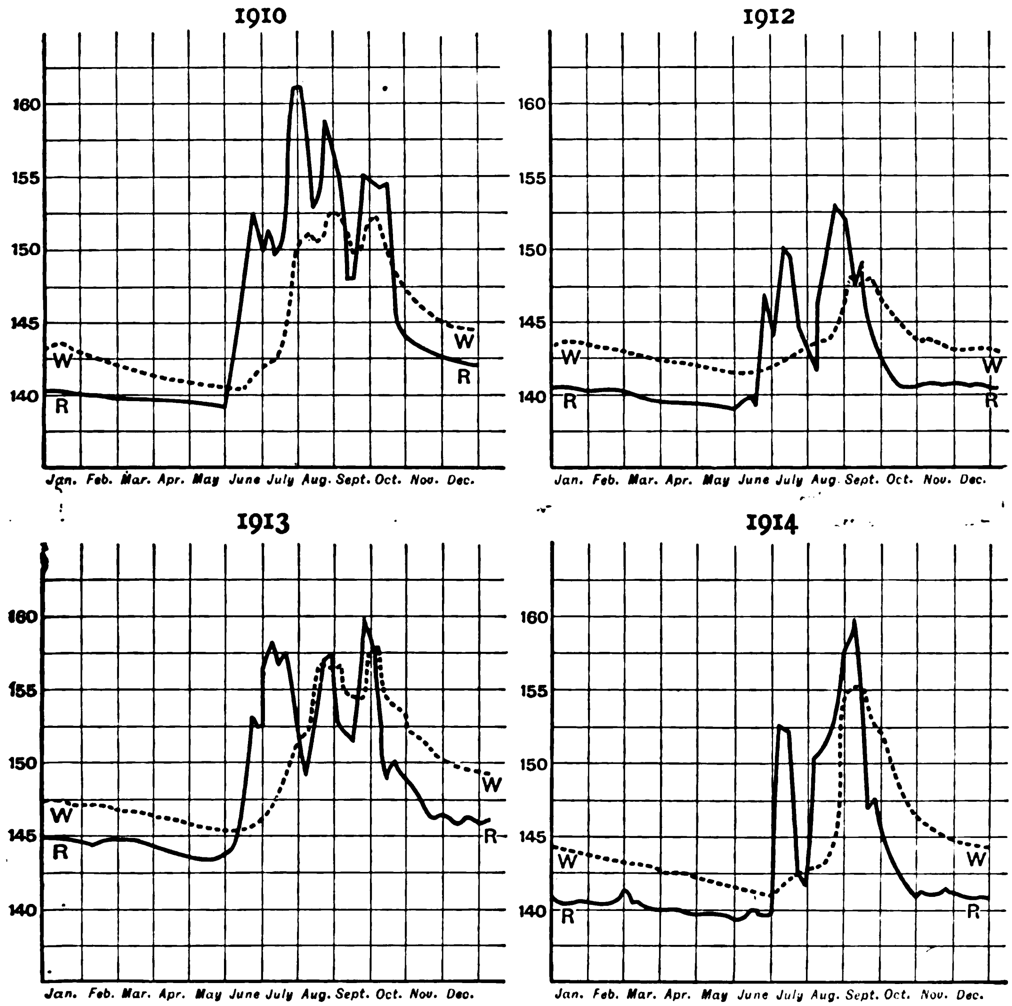

PLATE IV.—CHANGES IN THE RIVER AND WELL LEVELS AT PUSA.
The well levels are shown by dotted lines.
The observations are expressed in feet above mean sea level.

in the study of the root systems of the various crops grown and of some obscure plant diseases. Soon after the ground water rises in July, the absorbing roots in the lower levels of the soil die off, while those in the surface soil exhibit marked aerotropism in some cases, leaving the soil altogether and running over the surface of the ground. Deep-rooting crops of all kinds suffer from wilt, while surface-rooting crops escape (Fig. 2, p. 572).

The varieties of *H. Sabdariffa* (Roselle) have a superficial root system and the absorbing roots are markedly aerotropic. They thrive in the wettest years. Most of the types of *H. cannabinus* are deep-rooted, and these lose their absorbing roots after the soil water rises, and always suffer from wilt. Only one variety of this crop is surface-rooted: this thrives exceedingly well in the plains. Many other similar cases have been examined. In every instance surface-rooting varieties thrive in the rains in North Bihar, while the deep-rooted kinds without exception suffer from wilt diseases.

While the cultivator can often do a certain amount to improve the surface drainage of his fields, he is quite unable to cope with the larger aspects of the subject. Observations indicate that in many parts of India the surface drainage of large areas is defective and the crops suffer from poor soil-aeration. In some cases, this is due to the existence of extensive, shallow, cup-shaped depressions which are unable to discharge the run-off quickly. In others, the general surface drainage is partially held up by roads, by embankments, and by bridges provided with insufficient water-way. Such problems are

clearly beyond the means of the zamindar. They need for their solution the services of the engineer. A detailed drainage map of the area to be improved is obviously the first condition of success. From an inspection of some of these areas in the plains it would appear that a great deal could be done by the provision of a system of drainage canals by which the run-off can be passed either into rivers or led slowly through rice areas at a slightly lower level.

The difficulty in matters such as these is to make a successful beginning. The first step appears to be the study of the general drainage of a few of these partially water-logged tracts of the alluvium, the preparation of a drainage map combined with a study of the rivers where this is necessary. The drawing up of definite working-plans would follow, and progressive landowners would probably be found who would be willing to execute a small project under direction. These proposals do not involve a great deal of expense. A certain number of engineers with the necessary agricultural insight in all probability exist in the country now and, if set to work on this question, would rapidly justify themselves. Their assistance in this matter is essential. The cultivators and zamindars are so intent on their own small areas of land that they cannot be expected to evolve a scientific scheme of drainage for the country-side. Clearly it is for the State to provide a directing hand. In this direction a step forward has already been made by one Indian Province. In the *Punjab Government Gazette* of September 28th, 1918, the constitution and duties of a Drainage Board for the province were announced. In the Government [illegible] on this matter it is stated that "water-logging is due to many other causes than seepage or over-irrigation from canals, for instance, imperfect natural drainage or the obstruction of natural drainage by roads, railways, irrigation channels and zamindars' embankments. The evil is of steady growth in parts of the province and in some places threatens not only the prosperity, but the health of the rural population and involves also serious loss to Government revenue. Hitherto it has been dealt with only spasmodically. There has been no settled policy either for investigation or for action. The question should, therefore, now be taken up for the province as a whole."

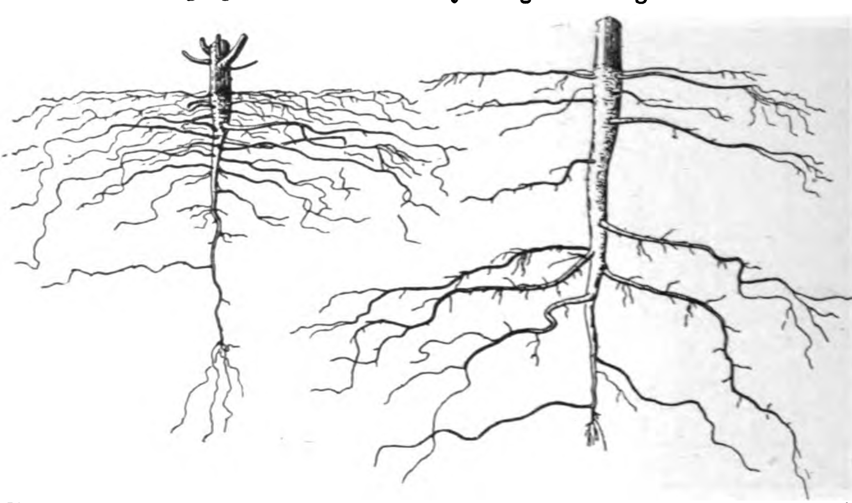

FIG. 2.—THE ROOT SYSTEM OF *Hibiscus Sabdariffa* (LEFT) AND *H. cannabinus* (RIGHT).

SOIL TEMPERATURE.

The investigation of soil temperatures is also yielding interesting results in India. As is well known, crops will only grow between definite limits of temperature. In Great Britain, the lower limit is most important; in India the reverse is the case and the higher limits affect growth more frequently. We see the effects of this factor at work on the large scale in the separation between the cold season and monsoon crops in Northern India, and in the geographical distribution of crops like gram (*Cicer arietinum*, L.). A line drawn from Bombay to Patna separates those portions of India where this crop is most important from those where it occasionally occurs. North of this line, the temperature in the cold season is much lower than in the south.

A most interesting case of the effect of soil temperature on growth has been worked out in Bihar, where one of the difficulties attending the cultivation of wheat has been found to arise

from a high soil temperature at sowing time. It frequently happens that the late monsoon rains fail and the onset of the cold weather is delayed. In such years, the soil and particularly the subsoil remain at a comparatively high temperature for some days after the usual sowing time of wheat. If the crop is sown at the usual time in such seasons, it germinates, but the seedlings do not thrive and are attacked and destroyed by white ants. The seedlings disappear from whole fields in a day or two, and over the countryside the wheat crop is wiped out. If the crop is re-sown at a later date on the same land it grows normally and practically no damage by white ants takes place. Investigations have shown that the cause of the damage is not the white ant, as is sometimes supposed, but the high temperature of the subsoil, which leads to the partial destruction of the root system of the seedlings. Afterwards, the white ants devour the sickly plants. The remedy consists in lowering the soil temperature by leaving the furrows open for a couple of days so as to cool the soil by evaporation, and by postponing sowing by about a week in such seasons.

As can readily be imagined, the investigation of problems of this nature, which may be termed exercises in applied physiology, are, perhaps, the most interesting which fall to the botanist in India. I trust I have been able to show that they are well worthy of further study and that they are certain to lead to results of great economic importance.

IV.—The Future of Economic Botany in India.

Up to this point the lines of advance in crop-production in India through the plant have been dealt with. At the same time, the wide range of the problems presented by the country has been indicated. The problems are obviously complex. Their solution involves a knowledge of science, of practical agriculture, and of trade requirements, as well as the faculty of combining these very different points of view. The country is large and the questions still to be attacked are very numerous. The mere size of the country and the large areas under any particular crop mean that even a small improvement in the yield per acre, when multiplied by the area to which the improvement applies, soon runs into lakhs of rupees.

What is the best means of getting such work done? The State is anxious that the volume of results should be increased. Should we rely on organisation, or should we trust to the individual? Both systems have their advocates. The answer, I think, is given by experience and by history. All notable advances in agriculture up to the present time have been initiated by individuals and not by systems of organisation. This applies to creative work of every kind. The individual has always triumphed over the committee or the organisation. Further, all organizations sooner or later become affected by disease. In India, this often takes the form of acute departmentalism.

What are the qualifications of the men who are to carry out the work? I think the subject to be investigated supplies the answer. The men must obviously be more than laboratory workers. They must look at the questions from three points of view—that of the scientific investigator, that of the cultivator, and that of the trade. Science is the instrument by which the advance is made. A first-hand knowledge of practical agriculture and the cultivator's point of view suggest the problems to be attacked. The uses to which the final product can be put or in other words, the requirements of the trade, gives the direction in which the advance can be most profitably made.

DISCUSSION.

The Chairman (Sir Robert W. Carlyle) said a letter had been received from Sir Daniel Morris expressing his regret at not being able to attend the meeting, and in that letter he wrote with regard to crop production in India:—"The work he (Mr. Howard) has done in this connection is of great value, not only to India, but to the whole Empire, and well illustrates the importance of enlisting the highest resources of science in the development of tropical and sub-tropical industries." It was, Sir Robert Carlyle continued, to the Howards that India owed the Pusa wheats, and it was quite possible that in the future even more important results might be obtained in the direction of reducing the waste of water. A beginning had been made, by Mr. Howard and others, of great importance in that matter, and, by dealing with the cultivators in villages as a whole, it might be possible in time to introduce a system of supplying water by measurement even on old irrigation canals. However that might be, it was most desirable that attempts should be made to introduce such a system in all new irrigation works. He was not quite sure that he followed the remarks on the future of economic botany in India. He agreed that the first thing was to secure ability combined with experience and that ability should be given a free hand, but organisation was indispensable in order to secure that the results obtained by the botanist were made use of by the cultivator.

Sir Claude H. A. Hill, K.C.S.I., C.I.E., said it was a great privilege to him to associate himself with what had fallen from the Chairman with respect to Mr. and Mrs. Howard. There were present at the meeting three fellows of the Society who had at one time or another been in charge of agriculture in India, covering a period of fifteen years, and during the whole of those fifteen years they had known and appreciated most highly the invaluable work done by Mr. and Mrs. Howard. With regard to what was said in the paper about standardisation from the industrial point of view, a good deal had been already done in the way of improving the quality of the produce of India, especially wheat and cotton. It was largely due to the efforts of the Howards that Indian wheat stood upon a wholly different footing to-day in European markets from that upon which it stood ten or fifteen years ago. As to cotton, the Committee which recently sat in India recommended that an endeavour be made to control the admixture of seed by establishing a system of licensing ginneries. It was in the gins that that mixture of seed had taken place. The Government of India had determined to act upon the Cotton Committee's advice and introduce a system of licensing. In connection with wheat there was a supplementary subject of very great interest and importance to the development of the industry. He alluded to the treatment of wheat commercially. It was becoming increasingly evident that India was seriously behindhand in that matter. During the war in one year nearly 2,000,000 tons of wheat were exported to the Allies, practically the whole of that export going from the port of Karachi, and being exported on a completely antiquated system. The normal exports amounted to less than 2,000,000 tons a year at present, but were bound, under the stimulus of improved production, to increase and to keep ahead of the increased consumption which was also taking place in India in substitution of other less nutritive grains. Unfortunately there was not a very strong public opinion to give expression to those views, but such opinion as existed was growing steadily in the direction that elevators must be introduced, and experts insisted that they must be introduced at first in the ports. It followed that the Karachi Port Trust must at no distant date adopt such a system. Last year the Government of India addressed the Bombay Government on the subject, and invited the urgent consideration of the matter by the Karachi Port Trust. Up to the time he left India recently no reply had been received, but it was quite natural that there should be some hesitation on the part of the Port Trust because, owing to the climate of Karachi, it was found to be exceedingly profitable to store the wheat on the open quays or leave it in trucks. That course was not in consonance with modern requirements, and it was earnestly to be hoped that the local Port Trust and the Government of Bombay would, at a very early date, enter upon the larger policy of expansion for Karachi. Mr. Howard had spoken of the reluctance of the cultivators to adopt new methods. Everyone present appreciated the fact that India over very large areas was tilled by small cultivators, who were practically proprietors of the soils and whose holdings sometimes ran to even less than an acre. Under such circumstances it was easy to conceive the difficulty an Agricultural Department had to face in inducing cultivators to adopt improvements, although the cultivator himself was a thoroughly intelligent person, and would, directly a thing was shown to be profitable, endeavour as far as possible to follow it up. The experience of a thousand years had taught him the exact limit up to which he could produce crops from the land without deterioration of the soil. Consequently he was very apprehensive of any intensive cultivation which he knew would, unless he was able to replace the wastage of the soil, result in soil deterioration. In Oudh some of the Zemindars had given up considerable areas to the production of pure seed, and the same thing had occurred in the Province of Agra. With reference to the suggestion of a development fund, he was not quite certain what Mr. Howard meant. A great deal had been already done by the development of co-operative credit societies for the purchase and distribution of grain, and hitherto there had been an inclination to hope that that was the line of development which would produce the best results. He did not know how Mr. Howard proposed that the development fund should be organised and financed. On the question of encouraging the production of improved seed in India, the Government had recently been considering the question of bringing into being an Agricultural Society on the lines of the Royal Agricultural Society in England. He had the pleasure of meeting on this matter the President and the Secretary of the Royal Agricultural Society last year, and he received the very greatest help and encouragement from them. Quite rightly, agriculture was to be one of the "transferred subjects," but if some stimulus was not applied there was a risk that Provincial Legislatures might hesitate to sanction the necessary expenditure. There could be no better stimulus than that which would be afforded by an unofficial Society of wide influence, commanding large funds. A conference to discuss the subject was to be held in Simla this summer. Mr. and Mrs. Howard had done excellent work in trying to effect water economy in India. It was not an easy matter to subvert the whole of the system on which the Irrigation Department of the Punjab had been organised, but he felt

certain that nothing but good could come of the further investigations now being made. He would like to claim for the Department of Agriculture in India that it had, considering all things, achieved considerable success. Cultivators in the remotest parts of the country now came to the Agricultural Stations dotted all over India, and, as far as their resources permitted, endeavoured to effect the improvements they had seen demonstrated. It was hoped that things would go ahead now on a very large scale in the matter of strengthening the Department, especially on its scientific side. Individuality was absolutely essential, but he could not see that it had been demonstrated, as was suggested in the paper, that organisation was relatively unimportant. He hoped the view would prevail that organisation was absolutely essential to the proper utilisation of the skill of the individual. Mr. and Mrs. Howard were now going to a sphere where individuality would have the fullest possible play, namely, to a new plant industry institute in Central India. Knowing what they had been able to do at Pusa, there was no doubt that they would achieve great things in the future, and he felt confident that the results of the work they would undertake in their new station would be carried through in co-operation with and to the great benefit of Pusa.

DR. J. A. VOELCKER said that Mr. Howard had shown in his paper what an enormous field there was for inquiry in the future in connection with the special science of economic botany, and had made it very clear that the inquiry was not only a large one but one which must be very systematically pursued. It involved the study of the requirements of India and of each place in India and of the various conditions which prevailed, and demanded something more than the individual cultivator could provide. The Indian cultivator, he thought, made better use of his facilities than the cultivator in this country made of his, but the selection of seed and the trying of new varieties was something beyond his power, and a well-organised department, such as the Agricultural Department, must be called in to help. It was satisfactory to learn that the excellent work which had been done was beginning to be appreciated by the cultivator. In the Report which he himself made he ventured to suggest the importance of extending the work of seed distribution and seed selection. There had been a certain amount of work done at Cawnpore and in the Bombay Presidency, but time was needed, and he was glad to hear that an extension of that work had since been carried on. Great care was needed in coming to definite conclusions with regard to seed selection and distribution, as it was not one condition alone that determined whether a fresh variety or a fresh kind of seed should be sown, but a consideration of a number of conditions, and it was in that direction that a well-organised department could assist. It was not an easy thing to get good quality combined with good quantity, and even in this country he did not think there had been any marked success in getting a wheat which would produce the yield of recognised varieties and combine the quality of hardness that was found in Canadian and other wheats. The extension of seed farms was most desirable. He would like to know whether the difficulty of the cultivator in getting an improved kind of seed still existed. About 1890 the real difficulty was for the cultivator to get out of the hands of the Banyas, on whom, at that time, the cultivator was almost universally dependent for getting his seed. Another very important branch of the subject was the question of nitrogen, and he did not think that the real solution of the question had yet been found. It struck him, on examining the soils of different parts of India, that they were very poor in certain respects, chiefly in regard to nitrogen. There was also the important point of the physical condition of the soil. Physical conditions in agriculture were quite as important as, if not more important than, the chemical conditions, and what Mr. Howard had said about the importance of paying attention to the amount of water and to the results of using water he could fully confirm from what he had himself seen and studied. Over-irrigation, producing water-logging, was apt to bring up injurious salts in the soil, and when heat followed, it produced a clogging of the land which was inimical to proper aeration and to the circulation of oxygen through the soil. As an official of the Royal Agricultural Society and as one who had gone out to India under their auspices, nothing would delight him more than to see an Indian Royal Agricultural Society; and any help the British Society could give to the Indian Government or the cultivators would be at their disposal.

SIR JOHN O. MILLER, K.C.S.I., moved a vote of thanks to Mr. Howard for his interesting and instructive paper. The paper was something more than merely instructive and interesting in a conventional sense; it was a very valuable contribution, especially the first part of it, on account of the spirit with which it was instinct, the only spirit in which he thought economic work could be carried out in a country like India for the benefit of the people. Mr. Howard said that the solution of the problem he had to deal with involved a knowledge of science, of practical agriculture, and of trading requirements, but in his paper he had shown that there was yet another factor to be considered. He had not allowed his investigations into the aspects of the elements of plant nature to obscure the

importance of human nature itself. It was no use producing agricultural products that were the best in themselves unless they could be also produced in such a way that the cultivator could make use of them. The Howards had achieved actual practical success in India such as perhaps had fallen to the lot of few. Mr. and Mrs. Howard once went to Quetta to assist fruit cultivation there, and found that, while there was room for improvement, the problem of immediate practical importance was to find a market for the excellent fruits already produced. For this reason, while their more scientific investigations were maturing, they set themselves to the prosaic task of making fruit boxes. That was an example of the practical spirit which had always characterised their work. It was a matter of great satisfaction that a scientific agriculturist had now come to strengthen the hands of the irrigation engineers in dealing with the problem of waste and misuse of water. The question of charging for water by volume was a very difficult one; but although it might take a long time to accomplish, that was the direction in which progress was likely to be made.

SIR VALENTINE CHIROL, in seconding the motion, said that amongst many varied experiences during his visit to India as a member of the Royal Commission on the Public Services of India, there were few that made such a lasting impression upon him as the visit he was privileged to make to Pusa, where he made the acquaintance of Mr. Howard. Although an absolute ignoramus in such matters, he was able to see in that institution a very valuable new organism for bringing the achievements of modern science within reach of the actual needs of the great agricultural population of India. He believed it was really providential that an institution of that kind for developing the agricultural productivity of India should have been founded in time to help us to face the present crisis, when one of the most serious questions with which the whole world was confronted was the shortage of agricultural produce, and that Pusa had been able to prepare India to fill up much more than it might otherwise have done the great gap which the devastations of the war had left in the production of foodstuffs.

MR. A. B. BRUCE, I.C.S. (Ministry of Agriculture), in supporting the motion, said it was desirable that people in India should realise what the reputation of the Howards in this country was. There could be no question whatever that the achievement of Mr. and Mrs. Howard ranked as one of the very greatest in the history of the application of science to practical agriculture. The only achievement that was at all comparable with their work was when science discovered artificial manuring, which, by introducing intensive farming, really revolutionised agriculture. He thought Mr. Howard would agree that the inspiration of the methods he employed came from the school associated very largely with Cambridge and the name of Bateson. The work of the Howards in India was an inspiration to workers here, and he hoped would in time lead to the adoption of better varieties in this country.

MR. J. S. BERESFORD, C.I.E. (late Inspector-General of Irrigation), in supporting the vote of thanks, said the improvements in irrigation in India had raised the value of crops enormously, and no doubt the value had been raised still higher by the selection and distribution of seed. It would be of interest to know whether recent developments had led to an increased yield of Egyptian cotton where tried in Sind. In Egypt the average yield was 600 lb. of ginned fibre per acre, the crop being sown in drills, and ten to twelve times depending on locality. With regard to drainage of water-logged soils and the illustration shown by Mr. Howard, he would like to know the distance apart of the drains and their depth. Regarding the experiment at Pusa in 1910 on a strip of land that had been intentionally submerged during the month of September, he could mention places in India and elsewhere that did not suffer from being long submerged. A notable instance was the successful basin irrigation in Egypt, where every year over one million acres of land, varying in character, was purposely flooded to a depth of 3 to 5 ft. during August and September, and the winter crop sown piece by piece on the saturated soil as the water was drawn off. He had had a great deal to do with making observations between rivers, especially the Jumna and the Ganges, where the level of ground water was not influenced by that in the rivers, but depended on the rainfall. The level rose gradually during and after the monsoon, attaining the maximum height about the end of December. The rise and fall were plotted in diagrams similar to those shown by the author. The results given in Tables 1 to 5 of the paper were valuable as showing what was possible under a special system of cultivation, and this on a small scale that admitted of close expert supervision; but he did not think the system was applicable to the vast areas of winter crops as ordinarily cultivated which had to be dealt with in practice, especially in years of deficient rainfall. Irrigation engineers had, during the last forty years, made numerous experiments in various directions with the view of economising water to the mere requirements of useful cultivation, and knew the obstacles in the way of this end. The best crop of wheat he had ever seen was on the Chenab Canal in 1897, when the supply of water was greater than the demand; the crop had been given eleven waterings, and the yield in grain was

found to be over 61 maunds per acre. Mr. Howard was no doubt well acquainted with the experiments carried out in America by King and others to ascertain the quantity of water required in the irrigation of various crops according to yield. Very often not more than 30 per cent. of the water from the head reached the field, and that was one of the difficulties in connection with selling water by measure.

The motion was carried unanimously.

MR. HOWARD, after acknowledging the vote of thanks and the many kind references which had been made to his work and that of his wife, said that in all research work the pioneer, the man who had to find his way into the unknown, should be unfettered and allowed to work out his own salvation, but when he had found, results, he agreed with Sir Robert Carlyle and Sir Claude Hill that organisation should come in and make use of them. With reference to the question of finance, he did not refer to the general financing of seed amongst the people, but to the difficulties which members of the Agricultural Department had in financing the seed they controlled and the seed occasionally bought from cultivators. It would be a great help if there was a development fund, because the Deputy Director of Agriculture was hampered by the existing account rules. The work went on continuously, and often involved credit, and it was necessary to have a running account and not an account which closed each year. In connection with nitrogen, several chemists in India thought there was an enormous amount of fixation by the soil organisms in addition to the fixation by leguminous plants, and that matter was being investigated. It was found in practice that if the supply of organic matter in the soil was kept up, it was possible, without the slightest fear of exhausting the land, to grow large crops of improved varieties, and there had been now fifteen years' experiments on that point. With regard to the amount of wheat that could be grown on one irrigation, the last result at Quetta showed that thirty-two maunds of grain were obtained with one watering, and Quetta was one of the driest places in India. Provided the soil was properly managed, it was remarkable how little irrigation water was needed for ripening large crops of this cereal. The illustrations of the drains shown referred not to the drainage of water-logged soils but to the control of surface drainage. In reply to Dr. Voelcker's question about the difficulties of supply of improved seed to the cultivators, these still existed and the demand was almost always much greater than the supply. This matter was now being dealt with in India as rapidly as the resources of the Agricultural Department permitted.

BRITISH COTTON-GROWING ASSOCIATION.

The annual report of the British Cotton-Growing Association for the year 1919 describes the work carried out by the Association in the development of cotton growing in India and the Colonies. It is hoped that the proposal to lease 7,500 acres in the Montgomery district of the Punjab Province, in order to demonstrate the possibilities of cultivating improved types of cotton, may be carried out in time for operations to begin in 1921.

Substantial progress is being made in cotton growing in Rhodesia and South Africa, where the industry seems likely to become established on a permanent footing. Efforts are being made to improve the staple, and a prize scheme has been inaugurated to encourage planters to cultivate the best varieties on a more extensive scale.

The Sudan Government Loan for £3,500,000 for developments, including railways, irrigation, etc., was successfully issued during the year.

The possibilities of Mesopotamia are discussed, and it is stated that experiments have established the fact that the country offers immense possibilities in cotton growing, the yield per acre in many cases being higher than is obtained in any other part of the world. The Council of the Association have decided to send out a ginning plant, and to begin direct operations without delay.

The report adds that when the necessary extensions and improvements in transport facilities, etc., have been carried out in Nigeria, Uganda, Sudan, and Nyasaland, a steadily increasing quantity of cotton will be produced in those districts where it has been proved that cotton, eminently suitable for Lancashire spinners, can be grown on an extensive commercial scale. The importance of this is emphasised by the fact that not only does the growth of American consumption show the urgent necessity of extending cotton-growing areas in British territory, but the mills of the United States are taking larger and larger quantities of the Egyptian crop.

THE MALAY PENINSULA.

Some interesting information is contained in a short article on the Malay Peninsula in the *Empire Mail*. For many years the Peninsula has been the chief source of the tin supplies of the world. It is also the principal rubber-growing country; and it was recently stated by Sir Frank Swettenham, a former Governor of the Straits Settlements and High Commissioner of the Malay States, that there is upwards of £100,000,000 of British capital invested in the plantation industry in the Peninsula.

INCREASING TRADE.

At one time it produced sugar and coffee in large quantities, but nowadays the export of both is negligible. Copra, tapioca, areca nuts, indigo, spices, gums, gutta percha, gambier, rattans and canes, raw hides, tungsten and scheelite are amongst the exports of the country; but tin and rubber are

the mainstays of its trade and have brought it prosperity. Some idea of the extent of the trade may be learned from the value of the imports and exports passing through the Straits Settlements—Singapore and Penang being the principal ports of the Peninsula. The following figures show the value of the trade in 1918 and 1919:—

	1918.	1919.
Imports . . .	£89,446,602	£107,453,544
Exports . . .	80,722,501	110,981,637
Total . .	£170,169,103	£218,435,181

After making due allowance for the increase in values of goods all over the world, it must be admitted that the above figures represent a considerable volume of trade. With the development of the country and an increase in its exports, there must necessarily be a growing demand for manufactured imports, for there are few local industries on a large scale and most things have to be imported from abroad.

Better known to-day than it was a quarter of a century ago, there is still a good deal of ignorance as to the political divisions of the Malay Peninsula. That portion of it which comes under British control and administration may be divided into three categories—the Colony of the Straits Settlements (which include Singapore, Penang and Province Wellesley, Malacca, and the Dindings); the Federated Malay States (Perak, Selangor, Negri Sembilan, and Pahang); and the Native States of Johore, Kedah, Perlis, Kelantan, and Trengganu. The Governor of the Straits Settlements (at present Sir L. Guillemard, K.C.M.G.) is also High Commissioner to the whole of the Malay States, and resides at Singapore. The Federated Malay States, whose Federal capital is at Kuala Lumpur, in Selangor, has a Chief Secretary (Sir E. L. Brockman, K.C.M.G.) and a Federal Council, and there is a Council in each of the four States, with a British Resident. The administration of the Colony and of the Federated States is staffed with Europeans, and the connection with the Colonial Office in Downing Street is a close one. In each of the other Native States there is a British Adviser, whose advice is followed by the native rulers.

Transport Facilities by Rail and Road.

The opening up of the Peninsula has been rapid since the British authorities undertook the supervision of its internal affairs. There are over 1,000 miles of railway, the British system being now connected with the Siamese and giving quick transit between Singapore and Penang with Bangkok, the capital of Siam. There are over 3,000 miles of road, unrivalled in the tropics and suitable for motoring.

Since their federation, the Malay States have advanced enormously in civilisation. In 1875, the aggregate value of their trade was only £297,882; in 1905, it was £13,471,539; in 1915, £26,106,872; and last year (1919), £40,550,000. The value of the tin exports was £8,745,635 and of rubber £22,059,244. Johore has made great progress during the past ten years. It is largely agricultural, with rubber and cocoanuts as its staples, but tin has been discovered and is now being worked profitably. The other States not in the Federation came under British suzerainty in 1909. Here substantial progress is also being made under the guidance of the British Advisers, and the general outlook is such that one is safe to predict that the Malay Peninsula, provided it can obtain a plentiful supply of labour, will take the foremost place amongst the tropical possessions of Great Britain.

RESOURCES OF FINLAND.

The following information regarding the resources of Finland is given by a correspondent in the *Times Trade Supplement*:—

The export trade of Finland comprises principally timber, chiefly in the shape of sawn goods, but also pitprops, etc. Sales of sawn goods in 1913 reached 625,000 standards (at 165 English cubic feet), of which 550,000 standards were shipped. At the beginning of 1919 stocks amounted to 1,100,000 standards, of which 580,000 standards were shipped during that year.

In 1920 there was, therefore, a balance of 520,000 standards. As the production during the year is estimated at 3-400,000 standards it is hoped that 8-900,000 standards will be shipped. The export of bobbins is also considerable.

The second place in Finland's exports is taken by the products of the paper industry. These comprise:—

		Tons.
Mechanical pulp and boards . .	about	150,000
Chemical pulp	,,	250,000
Paper	,,	200,000

In connection with the timber industry the production of three-ply wood may be mentioned. This is constantly increasing, but the production of ready-made doors, windows, and houses has so far not yet reached high figures.

The match industry in Finland is old established, its products having been sent to Western Europe, the Mediterranean countries, and, in exceptional cases, to the ports on the Black Sea.

Dairy produce has taken a prominent place in export trade. Considerable quantities of butter used to be sent to the United Kingdom, and of butter, milk, and cheese to Russia. The export of butter will hardly reach a high level during the near future, owing to increased home consumption through higher standard of living. On account of the difficulty of importing sufficient quantities of cattle food, butter production is hampered. Butter shipments to the United Kingdom have already taken place this year, and will be possible again after Finland's own demand has been satisfied.

The export of live stock, which in previous years was considerable, particularly to Sweden, is at present insignificant; but a fairly important trade in wild fowl and furs has sprung up. Hides,

particularly calf hides, have been exported during the past few years.

Quite an important development has taken place in the wood distillation industry. Owing to the application of modern technical methods, the export of tar and turpentine is beginning to show good results.

Amongst articles of export should also be mentioned granite, cut or uncut, and in the near future window glass.

OPENING UP WESTERN CHINA.

The increasing traffic on the Upper Yangtse is commented on by the Shanghai special correspondent of the *Times Trade Supplement*. For the first time an American trading firm is now entering the trade of Szechuen.

The Standard Oil Company had its own steamers running between Ichang and Chungking, but no American firm engaged in general trade has seen fit to engage in business in this part of the world.

Now, however, a United States concern has purchased one of the Standard Oil Company's vessels, and has adapted this to carry general cargo. This friendly competition will do much to develop the vast resources of Szechuen. In addition, a trading concern in Hankow, has placed an order for a special type of steamer for this service with a firm on the Clyde, on behalf of Chinese purchasers. Negotiations are in progress with the representatives of other United Kingdom shipbuilding firms for two more steamers, all for Chinese interests.

The ordering of steamers for the Upper Yangtse trade by Chinese is a very good illustration of the readiness with which they will adopt machinery and modern methods when it is actually demonstrated to them that these possess advantages over their own time-honoured methods. For centuries all traffic through the Yangtse gorges was by junk, laboriously towed up by man-power. It is estimated that the loss of cargo, through the junks being wrecked on the rocks in the gorges, in the last season was 60 per cent., whereas only one accident occurred to a steamer, and that through sheer incompetence. With such an object lesson before them, the Chinese are hastening to obtain steamers for the service. So far, British design and principles have been adopted.

The opening up of these hitherto undeveloped territories will mean a big demand for modern machinery and appliances, but, above all, for small power units. Oil and suction gas-engines especially will be wanted, and those interested in the manufacture of these should lose no time in conducting a properly organised campaign to demonstrate their uses. It is seldom realised how readily the Chinese adapt themselves to the use of modern machinery, and they are beginning to see the advantages of small power plants which they can install in their homes. It is not only in remote areas that this demand for machinery is growing. Where electric power is available a demand exists for small motors, and this branch of the machinery business has not yet been thoroughly exploited. For instance, there are thousands of looms worked by man-power all round Shanghai in native homes which use electric light. It is not a big step from electric light to electric power, but the advantages want systematic demonstration. With regard to the provision of funds for Shanghai's electricity extensions, a gold loan was sanctioned, and this has now been issued. It is a sterling loan, which should be popular, and the Council ought to have no difficulty in raising all the money it needs.

It is difficult to realise how enormous the field for machinery and engineering plant is in China until figures are studied. Recently an opportunity occurred of seeing what a leading British firm was doing in the machinery and engineering market. Before the war the total staff of its engineering department consisted of about six persons. The staff of that department to-day consists of more than forty men, and that number is to be doubled, orders having been telegraphed to their London office to engage a number of men immediately. The offices occupied by the engineering department of this particular firm cover a space at least four times greater than before the war, and further extensions have had to be arranged.

THE SOUTH AFRICAN FRUIT INDUSTRY.

The production of citrus fruits in South Africa was in the past confined to comparatively small areas, and the annual income derived therefrom a matter of small moment. There was no inducement to plant large numbers of orange and lemon trees, because the total white population of the country was small and the demand limited. As soon as it was demonstrated that oranges could be successfully exported to the European markets the matter assumed another aspect, and it was gradually realised that here was a business which could be exploited to an almost unlimited extent.

Just as South African deciduous fruits arrive in Europe at that season of the year when the market there is bare and there is no competition, so do the citrus fruits arrive when the supply from Europe and North America has ceased, and South Africa has almost a monopoly of the orange business from June until October. This means that it is now possible to obtain in Europe South African citrus fruit of all kinds just at that period of the year when they are most appreciated and are most beneficial from a health point of view.

An interesting account of the progress of fruit-growing in the Union and the development of an export trade, with special reference to citrus and other non-deciduous fruits and to berries, recently appeared in an official publication issued in South Africa, and formed the subject of a report to his Government by the United States Consul at

Durban, from which the following extracts are taken:—

Oranges.—Oranges are grown principally in the Transvaal, Cape Province, and Natal. Very few groves exist in the "Orange" Free State, its name notwithstanding, and from a commercial point of view these are negligible. The area of land suitable for citrus fruit is more extensive in South Africa than that on which any other fruit will thrive, and for this reason it will be readily seen that the orange will be the leading export fruit within a few years. The suitability of vast tracts of land in the Transvaal and Cape Province to the growth of the orange is demonstrated in the thrifty appearance of an occasional tree planted where there happens to be a little water available.

The exportation of citrus fruit commenced in a small way in 1907, since which time considerable though not uninterrupted progress has been made. Each of the three producing Provinces is represented in the export figures. Very little difference occurs in the numbers shipped from the Transvaal and those from Cape Province. At one time the bulk of the citrus fruit exported from South Africa was grown in the Transvaal, then the Cape took a slight lead; now indications point to an increase in the Transvaal production.

Inspectors at ports and local shippers estimate the quantity of citrus fruits available for export in 1920 at:—

		Tons.
Cape Town, 200,000 cases . . .	equal to	11,111
Port Elizabeth, 40,000 cases . .	„	2,222
Durban	„	2,000
Mossel Bay, 10,000 cases . . .	„	555
East London, 3,000 cases . . .	„	166
	Total . .	16,054

The varieties of oranges for export have in the past consisted of the ordinary seedling of the country, with perhaps half a dozen of what may be termed "popular standard varieties." About 75 per cent. of the total have been seedlings. Future plantings, and consequently exports also, will undoubtedly, as has been the case in California, consist of standard kinds, and the favourites will be Washington Navel, Valencia Late, St. Michaels, Joppa, Jaffa, Mediterranean Sweet, and Malta Blood, in approximately the order named.

Naartjes, Grapefruit, Lemons, and Seville Oranges.—"Naartjes" in South Africa mean something like tangerines and mandarin oranges in any other country. At all events, the word "naartje" has become distinctively characteristic of the fruit, not only in South African markets, but in those of Europe. It is a pretty fruit, the popular varieties considerably smaller and flatter than an orange, and the flesh so beautifully divided into separate segments that a lady can eat a naartje without soiling a new pair of gloves. This is the reason why this fruit is called in the United States the "kid-glove orange."

The demand for grapefruit is larger in America than in any other country. As South Africa has not hitherto grown any to speak of, the Union has not been able to tap this most profitable market. The few hundred boxes that have been exported from South Africa have been sent to London, where the demand is also good and prices equally so for the right article.

As an export fruit, the lemon has not hitherto proved a success. This is attributable to the simple facts that in the first place over-sea prices are too low to appeal to South African growers, and, in the second, the supply of Mediterranean lemons is so large and the handling of the crop so economically done that there are few months out of the twelve during which the South African article has any opportunity of striking anything but a full market.

The Seville orange, known the world over as the Bitter Seville, is the one orange which is preferred for marmalade. No other kind makes such a beautifully clear product, and, although in California great efforts are being put forth to create a demand for marmalade made from the Washington Navel orange, the choicest marmalade is, and will continue to be, made from this fruit. The local demand for this fruit has been very small until the last few years, when a demand has arisen for better-class marmalade, with the result that the Seville was more in demand. Possibly there are not more than 5,000 Seville orange trees in South Africa to-day, and they are not worth planting to any extent, although good prices should be obtained for some years to come. The trouble is that the Spanish product is available in such huge quantities and at such low figures that prices are forced down below the limit which South African growers regard as profitable.

Berries and Bush Fruits (Olives).—Berries and bush fruits are conspicuous in South Africa by their absence, the only berry grown to even a moderate extent being the strawberry. This is produced in every Province of the Union. More prominence is given to it perhaps in the western part of Cape Province than in any other area. This is accounted for by the fact that there is a large demand there for strawberries for jam purposes, some of the largest factories in the Union being situated in that district. Near Johannesburg and other large towns strawberries are grown purely for local consumption, and the demand is still in excess of the supply. The English Laxton strains are favourite varieties, as are also Melba and British Queen.

The raspberry grows and flourishes in parts of the Transvaal, the eastern part of Cape Province, in Natal, and Basutoland. Little attention has been paid to its cultivation, and a valuable and exceedingly delicious fruit is practically unexploited.

The blackberry is to be found growing wild in many parts of the Union. In the western part of Cape Province it is most prolific, and has been in demand by the jam factories for many years. Little, if any, attention has been paid to the cultivated varieties.

The English gooseberry does not grow to perfection in any part of South Africa. The only places where it is to be found of even moderately good quality are on the high veld in the Transvaal and at some fairly high elevations in the eastern part of Cape Province.

"Cape" gooseberries make one of the most delicious preserves. They grow almost anywhere and with a minimum of attention; in fact, they are often regarded as weeds. As a cultivated crop they pay well and are worth about 3*d.* a pound (cleaned) at the jam factories. Not many are cultivated, but the demand is always present, and this berry should receive commercially a great deal more attention than it does. Growers should make sure of a market before embarking on the planting of large areas, though most of the jam factories are willing and anxious to enter into contracts for the supply of this fruit.

Wild olives are found through the length and breadth of the Union; they flourish in the Cape, Natal, and Transvaal. It is therefore assumed that cultivated varieties will thrive correspondingly; but so far all attempts to establish a successful olive industry in South Africa have failed.

Avocadoes, Mangoes, and Loquats.—The avocado, often wrongly termed the "avocado pear," rejoices in the appellation of "alligator pear" in the United States. The tree as known in South Africa needs a warm climate, and is recognised as being one that will not put up with low temperatures. The avocado is grown principally in Natal and the warmer parts of the Transvaal, and the fruit is one which has undoubtedly a future before it. It is particularly rich in oil, and is one of the most nutritious and wholesome to eat. Unfortunately the varieties grown in South Africa at present are not suitable for export.

Mangoes are grown to greater perfection in the Barbeton district of the Transvaal than in any other part of South Africa.. The culture of this fruit there is of comparatively recent origin, and the production of choice varieties entirely so. Natal also produces mangoes perhaps even in larger quantities than the Transvaal, but, owing to the fact that atmospheric conditions are too damp in the vicinity of the largest plantations, the same success has not been attained in the growth of the mango in that Province. Many of the best varieties from India and Ceylon are obtainable, and although the trees have not up to the present attained the magnificent size of those growing in the countries named, they are shaping extremely well, and with age will yet make trees of respectable size. The nomenclature of the different varieties has been sadly neglected, and local names have now been largely adopted; such, for instance, as the Peach, Sabre, Kidney, and Large Green. These names indicate to South African growers and consumers the variety alluded to, but afford no guaranty to the stranger seeking knowledge. A few mangoes were exported about 1908 and realised such attractive prices that a boom in mangoes at once became imminent. It was, however, staved off temporarily, thus affording time to decide on the particular types of mango to plant for export. These eventually proved to be the Peach, Sabre, and Large Green, the first-named leading on account of its size and handsome appearance and immunity from "blackspot," which is the one disease to which the fruit appears to be subject in South Africa.

The loquat is another handsome fruit tree, though it is grown for shade in South Africa even more than for the sake of the fruit it bears. Its large, dark-green, glossy leaves and spreading branches afford a delightful shade during the "hot spells" with which South Africa is not unfamiliar. As far as the loquat as a fruit is concerned there is little to be said in its favour. Prices obtained are not sufficiently attractive to induce large plantings, and the few fruits found on the local markets are those from the trees already mentioned.

Bananas and Pawpaws.—As an ornamental plant or desirable adjunct to the garden for the sake of its foliage the banana is found all over South Africa. In Natal alone does the commercial aspect come into evidence, and even there cultivation is not anything like as extensive as it might be. It is true that in parts of the country a few bunches of common plantain-like bananas are to be found, but no actual business worth mentioning exists outside Natal. The Natal banana (*Musa Cavendishii*) is the variety principally cultivated, although the Lady's Finger is also found scattered here and there throughout the Province. There has been some slight export trade to Portuguese and former German African territories, but the bulk of the fruit is sold within the Union. There is little likelihood of any development of an export business with Europe; the banana trade in that quarter is already well established with the West Indies and is in strong hands. Further, Natal can barely supply the Union's own requirements. There is an occasional brief display of interest over such products as banana flour and banana coffee, but Natal growers at any rate can afford, as long as moderately good prices are obtainable, to neglect side lines of this description. It appears unlikely at present that any development of an extensive nature will occur in the planting of bananas. The business is principally in the hands of Indians, and, no matter how desirable these may be as vendors and distributors of fruit, they do not make good fruit growers. The tendency displayed is to take all that it is possible to get out of the ground without making any corresponding return. Under these circumstances, then, no immediate development of the banana industry can be looked for, yet the quality of the Natal banana is equal to any that grows.

The pawpaw grows principally in Natal and the low veld of the Transvaal, and is one of the most acceptable of fruits. In order thoroughly to appreciate it one ought to live in a fairly hot part of the country, where its non-appearance at

breakfast or dessert always causes long faces. The tree grows readily from seed and bears fruit sometimes under twelve months from the date of planting. An average time before bearing is eighteen months. Pawpaws are sold largely in Johannesburg, which is really the principal market in South Africa, and to a lesser extent in the towns of Cape Province, where the fruit does not seem to be as well known as it deserves. It is an extremely profitable tree to grow, though there are few orchards of pawpaws. There is one instance, however, of a pawpaw farmer, who gives all his time to the production of this fruit and makes a good living out of it. Inquiries have been made recently with regard to the extensive cultivation of the pawpaw for the purpose of producing papain, which is the active principle of the fruit, and has been used both medicinally and for dental purposes. It is a moot point as to whether the papain can be produced at a price sufficiently low to compete with the same products as turned out in the West Indies and other countries where labour is more plentiful and less expensive than in South Africa. There is little doubt but that the pawpaw is among the most healthful of fruits to eat, and as an aid to digestion possesses remarkable properties. It is an old and true tale that to reduce tough steaks to tenderness it is only necessary to wrap the meat in leaves of the pawpaw.

Pineapples.—Pineapples, like most fruits of a more or less tropical character, thrive in Natal, the eastern part of Cape Province, and parts of the Transvaal. Natal was first in the field as a producer of pines, and has grown and exported them for a good many years past. The varieties grown most extensively are the Smooth Cavenne and Queen; the former is one of the largest and handsomest fruits South Africa has, but the latter, though far smaller (averaging perhaps 1½ lb. in weight), is, as a rule, of finer flavour. While these are and probably will remain the leading varieties under cultivation, there have been some five or six other kinds under trial at the Government experiment station at Winklespruit, Natal, though no outstanding success has so far been achieved.

The pine-growing area *par excellence* in South Africa is found between Grahamstown and Port Alfred, in the eastern part of Cape Province. Here may be found all that conduces to the production of pines of the finest quality. Sufficiently removed from the influence of the sea, this favoured area is still near enough to enjoy the moist atmosphere conducive to the raising of the best pineapples. More planting has taken place here than in any other part of South Africa, and, although the Queen pine was originally introduced to this district from Natal, that Province has been out-distanced as a producer. Recently the acquisition of the Langholm estates by the African Realty Trust has given an added impetus to the development of this industry. There are over 12,000,000 pines now planted on this tract, and land is being cleared and broken for the reception of still more.

Needless to say, the ordinary outlets are not expected to absorb the crops from this gigantic undertaking. As an aid to export, with which idea the plantations were originally started, an up-to-date cannery is now in course of completion at Port Elizabeth. We may therefore soon expect South African canned pines to figure largely on the menus of Europe. It has been stated that in 1920 the export of pineapples, principally of the Queen variety, will amount to 10,000 tons.

GENERAL NOTES.

Dairy Industry in Ontario.—In 1919 Ontario produced 31,900,000 lbs. of butter valued at 17,575,000 dols., 102,700,000 lbs. of cheese valued at 27,729,000 dols., milk and cream for the city trade, the ice-cream trade, and manufactured into butter on the farm 25 million dollars; and condenseries and milk powder factories ten million dollars, a total value of 80,274,000 dols. In his agricultural report for the last fiscal year the Dairy Commissioner for Saskatchewan shows the remarkable increase of 18·70 per cent. for the province in dairy production. Though ninety-seven cars of butter were reserved for home trade, a total of 2,425,000 lbs. of butter went to outside markets. The value of the dairy products is given as 3,180,622 dols.

Marl Deposits in Finland.—In Vasaholm, in Nogio, Finland, a deposit of mollusc marl has been discovered, writes the United States Consul at Helsingfors. The field is 1,630 ft. long, 130 ft. broad, and 20 ft. deep. It is estimated to contain 125,000 tons of usable marl. The chemical analysis shows calcium oxides and 80 per cent. carbonate of lime. The high percentage of lime renders the deposit important as a fertiliser.

Telephones in the United States.—According to a report issued by the Bureau of the Census showing the results of the census of telephones covering the year 1917, there are 53,234 separate telephone systems and lines. These lines and systems operated 28,827,188 miles of wire in the United States, and connected 11,716,520 telephones and 21,175 public exchanges. The messages or "talks" sent over these wires aggregated the stupendous total of nearly 22 billion, or, to be exact, 21,845,722,335. Figured on the estimated population of the country in 1917 this gives 211 messages per annum to every man, woman and child. The industry in 1917 gave employment to 262,629 persons, of whom 171,119, or over 65 per cent., were women. The sum paid out in salaries and wages amounted to 175,670,449 dols. These employees operated plants and equipment valued at 1,492,329,015 dols., which yielded operating and non-operating revenues of 391,499,531 dols.

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***All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.* (2)**

NOTICE.

REPORT ON THE "OWEN JONES" PRIZE COMPETITION.

With the kind assistance of the Director of the Victoria and Albert Museum, the Council again arranged for a competition of students of Schools of Art in accordance with the terms of the Owen Jones Trust. Notices were issued in October last stating that six prizes would be offered under the usual conditions, each prize consisting of the Society's Bronze Medal, and a copy of a book or books on Applied Art, of a value not exceeding £2, to be selected by the successful competitors. In addition to these, a Special Prize of £20 was offered for the best design (irrespective of class) submitted. The subjects of the competition this year were:—

Domestic Pottery and Table Glass.

Metalwork: Including work in Precious Metals, Ironwork, Jewellery, Enamelling, etc.

Textiles*: Including Lace,† Embroideries,† Openwork,† Dress Brocades, Dress Designs and Costume Accessories (including Fans), Printed Fabrics for Dress.

The date for the receipt of competing designs was fixed for June 26th, 1920, and arrangements were made for their inspection at the Victoria and Albert Museums.

The following judges were appointed by the Council to consider the designs submitted: Mr. C. Harling Comyns, Mr. A. F. Kendrick (Department of Textiles, Victoria and Albert Museum), Mr. T. C. Moore, Mr. Harry J. Powell, Mr. Bernard Rackham (Department of Ceramics, Victoria and Albert Museum), Mr. John Slater, F.R.I.B.A., Mr. P. G. Trendell (Department of Textiles, Victoria and Albert Museum), Sir Frank Warner, K.B.E., Mr. W. W. Watts, F.S.A. (Department of Metalwork, Victoria and Albert Museum), and Mr. James Yeo (of Messrs. Debenham).

Ninety-four designs or works were submitted by sixty-three competitors from seventeen centres. These figures compare favourably with those of last year, when fifty designs were sent in from nine centres by thirty-one students, though they are still a good deal smaller than the totals for 1917, when one hundred and twenty designs were submitted by seventy-three students from twenty-two schools.

The centres represented were:—

Belfast (1); Bradford (1); Coalbrookdale (2); Hyde (1); Leeds (5); Leek (2); London: Camberwell (1), Ealing (3), Hammersmith (2), Hornsey (6), Putney (12), South Kensington (1); Liverpool (7); Macclesfield (9); Northampton (5); Watford (1); West Bromwich (4).

The designs submitted included:—

Embroidery (29), Printed Fabrics (22), Pottery (10), Woven Fabrics (16), Lace (9), Metal Work (7), Painted Material (1).

There were no entries for glass, and of the ten entries for pottery and seven entries for metal work the judges did not consider any worthy of a prize and only one (in pottery) worthy of commendation.

The awards of the judges are as follows:—

SPECIAL PRIZE OF £20 AND PRIZE.

Evelyn May Scott, City School of Art, Liverpool.
Embroidered Panel for Fire Screen with Drawing.

PRIZES.

Dennis Arnold, School of Art, Leeds.
Design for Printed Cotton Voile Dress Material.

Jean Dick, City School of Art, Liverpool.
Fan in Limerick Lace with Drawing.

Catherine M. Spencer, Art School, Ealing.
Design for Printed Voile.

George Smith, School of Art, Macclesfield.
Woven Silk Dress Brocade.

COMMENDED.

Muriel Jones, Hornsey School of Art.
Nos. 2 and 3 of Sheet of Four Designs for Machine-printed Dress Fabric.

* It should be particularly noted that only certain classes of textiles are eligible each year.

† Designs for Bed-spreads, Table Covers, Cushion Squares and Tea Cosies were eligible.

Jean Dick, City School of Art, Liverpool.
Night Dress Case in Canvas Stitch (two-sided Italian stitch, background only worked) and Drawing.

Hazel L. Montgomery, City School of Art, Liverpool.
Circular Embroidered Panel.

Thomas Johnson, School of Art, Macclesfield.
Woven Silk Dress Brocade.

Robert Morton, School of Art, Macclesfield.
Woven Silk Dress Brocade.

William Ray, School of Art, Macclesfield.
Design and Draft for Woven Silk Dress Brocade and Executed Material.

Fred. Wright, School of Art, Macclesfield.
Designs for Woven Silk Dress Brocades.

Herbert Woodman, School of Art, Macclesfield.
Design and Draft for Woven Silk Dress Brocade and Executed Material.

Ethel Birchenall, School of Art, Macclesfield.
Embroidered Cushion Square.

Marguerite Elizabeth Bayley, School of Art, Northampton.
Embroidered Bedspread.

Dorothy Livingstone, Putney School of Art.
Sheet (Half-set) of 58 Designs for Lace.

M. Holman, Putney School of Art.
Design for Printed Silk. (Commended for design only—colour not approved.)

William Frederick Godfrey, School of Art, Watford.
Design for a Plate.
Design for Printed Silk. (Design commended, but scale of pattern considered too small.)

L. Cole, Ryland Memorial School of Art, West Bromwich.
Embroidered Table Centre worked in fishbone, button-hole and chain stitches.

A. B. Woodhall, Ryland Memorial School of Art, West Bromwich.
Corner of Table Cloth in Cut Linen Embroidered.

Arrangements have been made for the exhibition to the public of the competing designs as in previous years. They are now and will remain on view until August 31st, from 10 a.m. to 6 p.m. (on Sundays from 2.30 to 5 p.m.) in the Class Room, Department of Textiles (First Floor), Victoria and Albert Museum, South Kensington, S.W.

In announcing the awards the Council desire to express their thanks to the judges for the trouble they have devoted to the work and for the promptitude with which the awards have been made.

They wish also to state their appreciation of the assistance rendered to the Society by the Director of the Victoria and Albert Museum and his staff.

The full conditions and arrangements for the Competition in 1921 will be announced later.

PROCEEDINGS OF THE SOCIETY.

JOINT MEETING OF THE INDIAN AND COLONIAL SECTIONS.

A joint meeting of the Indian and Colonial Sections was held on Friday, June 4th, 1920; The Right Hon. E. G. Pretyman, M.P., in the chair.

The Chairman, in introducing the reader of the paper, said that no one was more qualified to speak on the subject with which he proposed to deal than Sir John Cadman, who had been acting for some considerable time as the official adviser of the Government, being the principal permanent official in the Petroleum Executive which had recently been created.

The paper read was—

THE OIL RESOURCES OF THE BRITISH EMPIRE.

By Professor Sir John Cadman, K.C.M.G., D.Sc., F.G.S., M.Inst.C.E.

To endeavour to compress even a brief *résumé* of the Empire's oil resources into the space of time which is allotted to me is a task of such magnitude that I realise at the outset that when I have finished addressing you I shall have barely touched the fringe of the subject.

So much publicity is being given to the subject of petroleum at the present moment, that it is a little difficult to explain what it all means. On the one hand an effort is made to show that one group of capitalists is more worthy and better fitted than another to develop the petroleum which probably underlies certain parts of the hinterland of Mesopotamia; and on the other hand the present world's shortage of petrol introduces famine prices, which, it is suggested by some, should be corrected by price-limiting machinery—which would result in focussing this shortage more acutely on those who adopted such machinery.

As regards oil in Mesopotamia, it is not new; it has been known for many years that Mesopotamia offers possibilities for the prospector, and it has been open to all comers to try their 'prentice hands in extracting it. Again an outcry has arisen in the United States that Great Britain is attempting to collar the world's oil supply.

That country has not hitherto enjoyed a stable Government, and it is only now that it is suggested that it should come under the mandate of Great Britain, and the responsibility of keeping law and order is relegated to the charge of a responsible Government, that the

prospect of acquiring concessions in Mesopotamia has suddenly become so attractive.

The enormous growth in the use of petroleum and petroleum products, stimulated in no small degree by the war, has led to a demand which at the moment threatens seriously to outstep the supply. Production, paralysed during the war by lack of material for field development, has not kept pace with requirements, and in consequence there is a world shortage, with the natural result of famine prices and an abnormal eagerness to explore new and untried fields. It is these factors which have directed attention to new sources of supply, and which have prompted your committee to invite me to say something about the oil resources of our Empire.

In order to enable you to bring this problem into proper focus, I propose to picture to you in the first place what the world's resources of petroleum are, and from where they may be expected to come, both geographically and geologically; and then, if I can, to indicate to you which are the probable new sources of supply, and how far these new sources fall within the boundaries of the Empire.

It will be noted by reference to the map of the world that the continent of North America produces to-day about 85 per cent. of the world's output of crude oil. The United States at present produces in her own territory nearly 70 per cent. of the world's oil output, while if the quantity produced by United States companies in Mexico is added, the total United States control in North America is at least 80 per cent. of the world's oil supply. It will be seen, further, that the British Empire produces only about 2½ per cent. of the world's supply, or, if Persia may be said to be under British influence, about 4½ per cent. of the whole.

All this newspaper chatter as to the imminence of British domination in oil is shown to be absurd when this tremendous disparity is realised.

We have depended on the United States for oil supplies in the past, and we must continue to draw largely upon her in the future—and for the invaluable assistance which we have received from her every sane-thinking person cannot fail to feel profoundly grateful.

It is only too true that the United States is herself consuming ever-increasing quantities of oil, and that her available exportable surplus of oil is dwindling. It has been said that the United States reserves of oil are becoming rapidly exhausted, but it is difficult to accept the very pessimistic reports which have lately been made public. Oil is not a commodity that can be easily measured, and no estimates, however conservative, can be strictly relied upon. We have seen in this country a parallel in the alarming rumours which predicted the early exhaustion of our coal supplies, and we have repeatedly seen how far from the truth the alarmist figures are.

Nevertheless, it is true that the greatest producer of oil to-day is absorbing more and more of her own supply, and it behoves us to look round to see, in the most friendly way, from where are we going to be served when the United States finds it difficult to supply us, and we, too, are calling for more and more of this vital product.

It is most unfortunate that the Press of this country and the Press of the United States, should at this juncture be hurling wild statements about, many of which are most misleading and inaccurate. It has been stated that Great Britain is developing an oil policy which definitely excludes the foreigner from participating in and helping to develop any of the Empire's 2½ per cent. production to-day, and that she is deliberately shutting the door to foreign capitalists. To those statements which have appeared in the Press the following comments may be offered:—

1. Certain requirements as to British directorates and domicile are imposed on petroleum-producing companies in some parts of the British Empire, but there is no general ban on foreigners of the nature alleged. Even where such restrictions are in force American interests are to be found at work—*e.g.*, in Canada the Imperial Oil Company, a direct and very powerful subsidiary of the Standard Oil Company, occupies a commanding position, and in Trinidad an American company, the General Asphalt Company of Philadelphia, controls one of the principal operating companies. While foreigners are excluded from India, there are no restrictive measures in Australia, New Zealand, South Africa, or Egypt.

2. It has been suggested that it is our settled policy to prohibit the sale of British oil companies to foreign interests, and even the transfer of shares in British oil companies to aliens. Any regulations of this kind were war measures of a perfectly natural and legitimate kind, and it is quite inaccurate and misleading to refer to them as part of the permanent policy of His Majesty's Government, and as indicating a determination to exclude foreigners from participation in British oil enterprises.

Again, in regard to Persia, the suggestion that Americans are under any special disability in that country is absolutely incorrect. As the Anglo-Persian Oil Company hold the concession other British and foreign interests are naturally excluded, but there is no truth in the statement that the Anglo-Persian Oil Company's rights have been in any way strengthened by the Anglo-Persian Agreement of 1918. The concession was acquired in 1901 through the individual enterprise of Mr. W. K. D'Arcy, and it was equally open to Americans or any other nationals to secure it.

As regards occupied areas, it has, as stated, been the policy of His Majesty's Government to prevent prospecting for minerals by British or foreign companies until the future administration of these territories is settled. When this has been done, rights claimed by American and other nationals will presumably be considered. The restrictions imposed have been considered essential to prevent confusion and friction.

The Oil and Coal Leasing Act, lately passed in the United States, contains a reciprocity clause providing that, if any country places restrictions on United States citizens in regard to the working of coal or oil, the nationals of that country should be excluded from any participation in the working of lands covered by the Act.

It is interesting to note that Mr. A. C. Bedford, of the Standard Oil Company, says that what is needed is an agressive foreign policy on the part of the United States Government; while Senator Phelan proposes the formation of a United States Oil Corporation to stimulate the development of foreign oilfields by Americans. As to this, it need only be said that in the past Americans have prospected or found oil in Roumania, Palestine, China, the Dutch Indies, Canada, Mexico, Costa Rica, Colombia, Peru, Cuba, Trinidad, and elsewhere. Any oil concessions which British subjects hold abroad have been acquired purely by individual enterprise, and they enjoyed no special advantage in the way of Government backing, nor did they wait to secure Government encouragement and support.

On this difficult question I can only say that Great Britain is too sensible of what she owes to those who have kept her so well supplied in the past, to adopt any attitude other than that of strict impartiality and fairness.

Having made these preliminary remarks upon certain aspects of the oil situation which are attracting attention to-day, I would ask you to consider under what conditions petroleum exists, and in what quantity may it be expected to occur within those conditions.

Liquid oils may be divided into two groups:—

1. Those which occur in Nature as crude liquids.

2. Those which can be obtained by distillation from shales and coals.

It is to the former group that I must direct attention this afternoon, although much of our future supply will probably be received from the latter group.

It is an interesting geological fact that the conditions which favour the deposition of natural petroleum seem to be associated with two definite geological horizons—viz., the Tertiary and the Carboniferous—and it was during this period that vegetation thrived on this planet.

The following table illustrates this point more precisely:—

THE GEOLOGICAL DISTRIBUTION OF OIL IN THE CHIEF OILFIELDS ARE AS FOLLOWS:—

Geological Formation.	Percentage Production.	Locality.
Tertiary	49·4	California, Gulf Coast, Mexico, and most of the British Colonies.
Upper Cretaceous	1·0	Texas, Wyoming, Colorado.
Lower "		
Jurassic		
Triassic		
Permian		
Carboniferous, Upper Devonian	41·1	England, Texas, Oklahoma, Kansas, Pennsylvania, Illinois, and the Appalachian field.
Devonian	0·4	Canada.
Silurian		
Ordovician	8·1	Lima-Indiana.
Cambrian		

I now propose to show very approximately how far these rocks are disseminated over the surface of the planet, and how relatively little has yet been done in prospecting for petroleum within this vast tract of land. I have indicated on the map of the world where these deposits lie, and you will see then how far they penetrate within the confines of the British Empire.

Out of approximately 60 per cent. of the globe's surface covered by these rocks, only an infinitesimal part has yet been thoroughly examined for petroleum products, and it must be some comfort to imagine that even if only a moiety of them are found to contain petroleum, the stores of petroleum in the world are still plentiful and only await discovery by the geological hammer and the drill.

The figures for production and consumption for 1918 were as under:—

	Production, 1918 Tons.	Consumption Tons.
United Kingdom	250,000	5,395,000
Canada	40,000	1,717,000
Trinidad	300,000	112,000
India	1,150,000	1,292,000
Egypt	250,000	424,000
Australia } New Zealand }	10,000	110,000
		67,000
Sarawak	80,000	—
Total British Empire	2,080,000	9,117,000
Persia	1,500,000	
World's Production	70,000,000	

The consumption and production of petroleum products in the British Empire has been approximately:—

	Consumption.	Production.
1912	4,212,000	1,421,000
1913	4,713,000	1,519,000
1914	5,467,000	1.563,000
1915	5,184,000	1,629,000
1916	6,128,000	1,655,000
1917	7,485,000	1,774,000
1918	9,117,000	2,080,000

The figures in the table below show approximately the present consumption and source of supply for the United Kingdom, although in 1918 the consumption was on the basis of $5\frac{1}{2}$ million tons per annum.

It may be interesting to review briefly the present position of the oil supplies of each zone within the Empire which is at present attracting attention.

Great Britain.

The United Kingdom is at present a comparatively small oil producer, practically all its requirements being drawn from overseas. Until quite recently (May, 1919) production was confined to the shale deposits of Scotland, which stretch from the Forth, between Dalmeny and Blackness, southwards to Tarbrax.

These oil-bearing strata produce about 3,250,000 tons of shale annually, the average yield being from nineteen to twenty gallons per ton of shale, or approximately 250,000 tons of crude oil. The output during the last eight years has been as follows:—

	Output of Oil Shale. Tons.	Crude Oil Produced. Tons.
1911	3,206,756	293,660
1912	3,284,956	294,699
1913	3,369,321	289,684
1914	3,388,869	285,464
1915	3,187,592	263,083
1916	3,102,036	247,472
1917	3,200,883	249,598
1918	3,223,076	242,501
1919	2,814,110	211,986

Deposits of shale have also been known for many years to exist along an irregular line stretching from Kimmeridge in Dorsetshire to King's Lynn in Norfolk, and on as far as Yorkshire. None of these deposits are being worked with the exception of the Norfolk area, which English Oilfields, Limited, are attempting to develop. Several seams are stated to have been proved, and the Company expect to be working on a commercial scale at an early date; but progress in development of a new shale field must necessarily be slow.

Imports of all Petroleum Products to the United Kingdom.		Consumption in the United Kingdom.	
Origin.	Quantity (Tons).	Products.	Quantity (Tons).
United States of America	1,800,000	Crude Oil	30,000
Mexico	500,000	Kerosene	620,000
Dutch East Indies	120,000	M.T. Spirit	650,000
British India	60,000	Lubricating Oil	260,000
British West India Islands	130,000	Gas Oil	120,000
Persia	90,000	Fuel Oil	1,020,000
Total	2,700,000	Total	2,700,000

Occurrences of natural petroleum have, from time to time, been reported from various points of the country, and in 1914 a systematic geological examination was begun by Messrs. S. Pearson & Son, and in October, 1918, they commenced drilling operations as agents of His Majesty's Government. A series of bore-holes were put down in the Chesterfield area, and in May, 1919, the Hardstoft boring struck oil, and flowed with a daily production of about ten or eleven barrels of oil, and it has since been steadily producing at this rate.

Tests are also in progress in North Staffordshire (Apedale and Werrington), and in Scotland (West Calder and D'Arcy), while at Kelham, near Newark, a well is being sunk by Oilfields of England, Limited.

An analysis of the Hardstoft oil is as follows:—

Motor Spirit	7·5	per cent.
Kerosene	39	"
Gas Oil	20	"
Lubricating Oil	30·5	"
Paraffin Wax	3	"
Sulphur	0·26	"
Sp. gr.	·823	

Calorific value 20,290 B.T.U.

Some idea of the requirements of the United Kingdom for petroleum products can be gauged from the following table:—

Year.	Production.	Imports.	Expressed in Tons. Totals.	Exports.	Difference (Consumption).
1912	294,699	1,653,333	1,948,032	26,846	1,921,186
1913	289,684	1,962,427	2,242,111	16,505	2,225,606
1914	285,464	2,586,850	2,872,314	20,444	2,851,870
1915	263,083	2,354,079	2,617,162	46,079	2,571,083
1916	247,472	3,159,195	3,406,667	27,907	3,378,760
1917	249,598	4,187,569	4,437,167	20,800	4,416,367
1918	242,501	5,166,218	5,408,719	6,996	5,401,723
1919	211,986	2,749,652	2,961,638	112,811	2,848,827

Cyprus.—Indications of petroleum in Cyprus seem to be confined to the dark-oil-bearing phase of a crystalline limestone, probably of Cretaceous age, occurring in the northern mountain range, but the physical character of this rock and the structure appear to be unfavourable for the accumulation of oil on a commercial scale. Four wells have been sunk without success, but, owing to the war, operations were suspended.

Malta.—There are rocks of suitable age and structure, and it is probable that test drilling will be undertaken.

Asia.

Persia.—The oilfields of Persia extend in a south-easterly direction along the western and southern sides of the Persian plateau adjoining Mesopotamia, the Persian Gulf, and Gulf of Oman, cross the Turco-Persian frontier between the Diyaleh (or Sirvan) river and Mendeli, and enter the Persian province of Kermanshah. Thence they run south-east through the provinces of Luristan, Arabistan, and the Bakhtiari country forming the northern area, and Behbehan Fars and Laristan forming the southern area.

It is uncertain how far the northern area extends to the north-east, but in the south-west numerous seepages are found in the gypsum and sandstone ridges forming the foothills of the south-west ranges of the plateau. The most important deposits have so far been found in the Bakhtiari country at Maidan-i-Naftun, about 140 miles north-east of Mohammera. The Naft Khana field on the frontier, about 16 miles north of Mendeli, has many surface indications. Luristan is believed to contain considerable deposits, and oil has been found at Kuh Dalpassi, about 120 miles north-west of Ahwaz, the general structure of the country being similar to that of the petroliferous regions to the north and south.

The southern area, in which practically little or no development has taken place, consists of a long belt of territory of unknown width extending along the coast from the head of the Persian Gulf to the Straits of Hormuz and Persian Makra, and may be divided into:—

(1) Scattered localities, known to be petroliferous, on the Persian littoral (with which may be included the island of Qishm, in the Straits of Hormuz) or within easy reach of the Persian Gulf.

(2) The mountainous hinterland forming the southern part of the Persian plateau, consisting

largely of wild and unexplored regions of the provinces of Fars and Laristan.

In 1901, Mr. W. K. D'Arcy obtained a concession from the Persian Government covering the whole of Persia except the provinces of Azerbaijan, Ghilan, Mazendaran, Asdrabad and Khorasan bordering on the Caspian Sea. The area of the concession is approximately 500,000 square miles, but only a few square miles have actually been worked, principally at Maidan-i-Naftun, where 3½ square miles have been proved and a substantial production is obtained. Oil in commercial quantities was, however, proved by the drill in the early days of the concession at Chiah Sourkh, north-east of Khanikin.

From Maidan-i-Naftun the oil is conveyed about 145 miles by two pipe-lines to the refinery situated on the Island of Abadan.

The output has increased from less than 100,000 tons in 1912 to about 1,000,000 tons in 1918.

The oil is of high quality, containing a large percentage of benzine, good kerosene and lubricating oils, fuel oil of unusually high thermal efficiency, and a good percentage of paraffin wax.

An analysis gave the following result:—

Specific gravity	0·840
Initial boiling point	48° C.
Distillation below 100° C.	11·0 per cent.
Distillation between 100° and 150° C.	12·3 „ „
Distillation between 150° and 280° C.	29·6 „ „
Residue	45·6 „ „

Mesopotamia.—The existence of petroleum and asphalt in Mesopotamia has been known since very early times. The oilfield in this country is only part of a petroliferous area which extends through Southern Persia to the north end of the Persian Gulf, passes through Mendeli on the Turco-Persian frontier, and crosses the Tigris near El-Fatha. The oil line follows the river to Mosul, and continues with interruptions to Zakho and the neighbourhood of Van following the Bothan river. This belt is approximately 1,000 miles long, and covers an area of more than 26,000 square miles.

Three main oil lines may be distinguished: the southernmost, on the Djebel-Hamrin, which starts at the oil wells of Mendeli and passes over El-Fatha to El Hadr; the second, which connects Kifri with Tushurmatu; and the third connecting Kerkuk with Garadagh. If the latter is continued in its north-westerly direction it leads directly to the petroleum wells of Tel Kyara. The existence of an oil line may also be assumed between the asphalt deposits near Hit, Nephata and Ramadi, and the oil deposits of Basra and Koweit. There are also numerous indications on the islands of the Persian Gulf.

Near Mendeli there are thirty pits, none of which are more than about 8 metres deep. The oil, which is dark and thick, gives on distillation about 30 per cent. kerosene, the residue being used as fuel. About 300 tons of crude oil are refined annually in this district. In the Tushurmatu district the yield of crude oil is about 700 tons per annum. In the neighbourhood of Kerkuk, over an area of about 37 acres there are about twenty springs giving an annual yield of approximately 300 tons of crude oil. The largest production is at present obtained from an area of about 246 acres near Tel Kyara, the annual production being about 1,500 tons. Near Zakho there are numerous seepages over an area of about 120 acres which give a yield of from 250 to 300 tons per annum. Along the Euphrates river the asphalt deposits of Hit and Ramadi have been known from ancient times, the yield of asphalt from the wells near Hit being estimated at about 2,500 tons per annum.

India.

Oil has been found to a small extent in the Punjab, in the Rawalpindi, Attock and other districts, but the main petroleum region of India is in the east—Burma, Assam, and the islands off the Arakan coast.

In Burma the oil producing area, which runs north and south, lies along the basins of the Irrawaddy and Chindwin rivers. Of the 400 miles along which indications exist, only about 90 miles have been found sufficiently profitable for development, the chief fields being Yenangyaung (Magwe District), Singu (Myingyan District), and Yenangyat (Pakokku District). The Yenangyaung field is the most important, its chief districts being Twingon and Beme. All these fields are connected by pipe-lines, which continue to the refineries at Rangoon. Other areas are Chindwin, Shwebo, Minbu, Thayetmyo, Prome, Henzada, Sittang Valley, and the Arakan region comprising Ramri Island and other small islands. The work in these districts has, however, been principally of an exploratory nature.

The oil has a specific gravity varying from ·800 to ·950. It is rich in kerosene, of which large quantities are consumed in India, and

also gives a valuable lubricating oil. The following is an average analysis :—

	Per cent.
Spirit	15
Kerosene	55-60
Solid Paraffin	12-14
Lubricating Oils	8-12
Loss and Coke	5

In Assam the principal fields are about sixty miles from the Thibet border, at Digboi and Makum. The bulk of the oil comes from the Digboi field, extensions of which have been proved at Bappapoong and Hansopoong. The oil is of paraffin base with a specific gravity at 60° C. of ·855 to ·860. An analysis is as follows :—

	Per cent.
Benzine	8·8
Kerosene	37·8
Lubricating Oils	49·4
Coke	3·8

There is a refinery at Digboi with a capacity of about 24,000 tons per annum, and tank storage has been provided both at the refinery and at the wells.

The total annual production of oil in India since 1908 has been as follows :—

Year.	Burma. Tons.	Assam. Tons.	Punjab. Tons.	Total Tons.
1908	693,611	12,972	2	706,585
1909	921,586	13,123	3	934,712
1910	846,031	13,283	4	859,318
1911	888,902	14,261	6	903,169
1912	981,341	14,990	4	996,335
1913	1,089,062	18,754	5	1,107,821
1914	1,018,612	18,754	5	1,037,371
1915	1,129,168	18,200	1,005	1,148,373
1916	1,167,076	20,948	735	1,188,759
1917	1,091,181	37,379	2,478	1,131,038
1918	—	—	—	1,146,340

The imports of all kinds of oil into India during the past four years have been as follows :—

		Tons.
1916		372,734
1917		288,749
1918		230,495
1919	(nine months)	321,760

The falling off in 1917 and 1918 was due to the scarcity of tonnage.

Africa.

Egypt.—The Egyptian oil region lies between 27° 10′ and 28° 10′ latitude north and 33° to 35° 50′ longitude east, with outlying districts on the western and south-eastern borders of Sinai; it runs parallel to the Gulf of Suez, and covers a width of from five to twenty kilometres. If the desert plain be included the area of the region is approximately 8,000 square kilometres, extending from Ismailia to Ras Buras, with a maximum breadth of fifty kilometres.

Gemsah was the main producing area up to 1914, but since that date its output has declined considerably, and commercial production is now confined to the Hurghada field, which is worked by the Anglo-Egyptian Oilfields, Limited, whose concession also includes the Gemsah field referred to.

The total production of these two fields since 1910 has been as follows :—

	Tons.
1911	2,793
1912	27,962
1913	12,618
1914	103,605
1915	34,961
1916	54,800
1917	134,700
1918	272,494
1919	232,148

Other districts where prospecting is being carried out are the west side of Gabal Zeit, Jaffatine Island, Ras Bahar (north of Gemsah), Gaysoon Island, Ras Dhib, Jubal Island, Ranim Island, and at Abu Zenina.

Storage tanks have been erected at Gemsah, Hurghada, and Suez, with a capacity of about 100,000 tons, and at the last-named place there is a refinery capable of treating about 1,000 tons of crude oil per day. Pipe-lines have been laid to deep water at three shipping berths at Port Tewfik.

The crude oil varies in quality, but that found at Hurghada is a heavy oil with a paraffin base.

Typical analyses are :—

Gemsah.—

Specific Gravity	·830 at 62° F.
Benzine (below 150° C.)	23 per cent.
Kerosene (150°–290° C.)	34 „
Fuel Oil (above 290° C.)	43 „

Hurghada.—

Specific Gravity	·928 at 62° F.
Benzine (below 150° C.)	10 per cent.
Kerosene (150°–290° C.)	14 „
Fuel Oil (above 290° C.)	76 „

Gold Coast.—Petroliferous lands are reported near the coast, in the neighbourhood of Appolonia and Birridaim. Wells have been sunk which prove the existence of various oil horizons, but no commercial quantities have so far been found.

Nigeria.—Indications of petroleum are found in Southern Nigeria, the surface formation consisting of sands of the Tertiary series underlaid by impervious shales, beneath which occurs hard limestone in which no traces of oil have so far been met with. With the assistance of the Nigerian Government drillings were commenced in 1905 in the neighbourhood

of the Oni River, Southern Nigeria. Six wells were sunk, but owing to difficulties in shutting off water the operations were abandoned.

Somaliland.—Geological expedition undertaken by Mr. H. T. Burls, confirmed at a later date by Mr. Beeby Thompson and Dr. Ball, revealed the existence in the Daga Shabell area, near Berbera, of a small field of asphaltic oil, rich in benzine, and apparently free from sulphur. A suitable series of sediments, presenting all the usual essentials of oilfields, is located over an area of many square miles, and oil-impregnated sands are found throughout a vertical thickness of 800 ft. in the lowest exposed beds of the series. The bituminous sands are reported to be progressively rich in oil as the lowest strata are approached. The oil is said to be of high grade, light density and sweet smelling quality.

A practical test of the field is to be carried out.

South Africa.—In 1913 it was reported that geological formations, favourable to the existence of oil deposits, were only to be found in a narrow strip at the southern edge of the Karroo, Cape Colony. The most important indications are those on De Drift and Oudeberg farms, in the Laingsburg Division, about twenty-nine miles north-west of Prince Albert Road Station, and on Ongeluksfontein, Tweefontein, and Varschefontein farms, some miles to the north in the Beaufort West Division.

In the district immediately surrounding Port Elizabeth the geological formation is said to be similar to that of the Caucasus belt, and it has been proposed to sink a test well about twenty miles from the town.

Oil-bearing shales have been opened up in various districts of the Union, but no payable deposit has yet been proved. The deposits in the Wakkerstroom field, Transvaal, showed on analysis an average yield of from 18 to 28 gallons of crude oil per ton of shale.

Beds of shale rich in oil are reported in Natal, and mineral oil is believed to exist near Harrismith in the east.

America.

Canada.—The areas where oil indications are met with in Canada are very numerous, but no serious effort has so far been made to develop them.

Natural petroleum occurs in Ontario, New Brunswick, Alberta, British Columbia, Newfoundland, and Athabasca, but the only area where regular production has so far been obtained is Ontario, of which the principal districts are Mosa, Oil Springs, Petrolia, Bothwell, Tilbury, Moore Township, Sarnia, Dutton, Thamesville, Plympton, and Onondaga. Recently, however, a gusher was brought in in New Brunswick having an initial flow of 10,000 barrels a day.

The total production since 1912 has been as follows:—

	Tons.
1912	34,762
1913	32,583
1914	30,686
1915	30,781
1916	28,303
1917	30,547
1918	43,534
1919	31,430

In Alberta indications of petroleum over large areas have attracted much interest, and considerable activity in development work is anticipated. Actual production, whilst not of much importance, shows that progress is being made, the figure for 1918 being about 1,863 tons compared with about 1,214 tons for 1917. Investigations along the Athabasca river show that the "tar sands," of which many millions of tons are available, are outcrops of sandstones impregnated with bitumen.

With regard to British Columbia, owing to the disturbed geological conditions, opinions differ as to the extent of natural oil deposits, of which there are occurrences on the coast. Oil shale deposits of considerable extent also exist.

Newfoundland.—Large deposits of bituminous shale, covering an area of about 150 square miles, are reported to exist near the west coast of Newfoundland, while similar deposits have also been traced at Deer Lake for a distance of 30 miles.

Traces of petroleum have been found on the shores of Parson's Pond, a stretch of salt water in bay formation, lying between St. Paul's Bay and Portland Creek on the north-west coast, facing the Gulf of St. Lawrence; attempts at development have not proved a commercial success, but they have recently been resumed.

Barbados.—Oil indications in the Scotland district, on the eastern side of the island of Barbados, have been found in the Tertiary strata, which is to some extent faulted and covered with coral limestone. In some places the coral beds are largely mixed with the debris of underlying strata, forming beaches, which not infrequently conceal important geological structures and render the following out of pre-coral flexures very difficult.

A small production of an asphaltic base oil was at one time obtained.

Trinidad.—Petroleum indications in Trinidad are practically confined to the southern part of the island along several more or less clearly defined parallel anticlines running from east to west, and all land south of latitude 10° 26′ 36″ N. has been officially declared oil bearing. The principal producing area is the Forest Reserve, near Brighton. Other districts are Mayaro, Guayaguayare, Tabaquite, and La Brea. There are three tenures of land: (1) Crown land, on which oil is the property of the Crown; (2) private land, where oil is also the property of the Crown; and (3) private land, where oil is the property of the landowner. During 1918, 47,487 ft. were drilled on Crown lands as against 6,751 ft. on private lands, the number of new wells drilled being thirty-seven on Crown and four on private lands, bringing the total number of wells drilled in the Colony to December 31st, 1918, to 410, of which 236 are on Crown lands.

Numerous oil gushers have from time to time been obtained principally from the upper horizon, production from the lower horizon being impeded by shifting sand, which tends to crumple up the casing and choke the bore-holes. It is hoped, however, that an effective remedy will be found for this difficulty.

Most of the oil has an asphalt base, that from the lower sands being much lighter than that produced from the shallow sands. At Tabaquite, an oil of paraffin base containing about 80 per cent. benzine is found.

The production in Trinidad since 1911 has been as follows:—

	Tons.
1911	17,516
1912	39,943
1913	70,506
1914	90,092
1915	147,015
1916	129,903
1917	224,324
1918	291,489

The largest and most important company is Trinidad Leaseholds, Ltd., which in 1918 had a production of 154,179 tons, *i.e.*, more than 50 per cent. of the total output for the colony. The United British Oilfields of Trinidad, Ltd., comes next with a production in 1918 of 88,054 tons; and other important companies are the Trinidad Lake Petroleum Company, Ltd., and the Petroleum Development Company, Ltd., with productions in 1918 of 18,282 tons and 16,478 tons respectively.

Pipe-lines run from the fields to the ports of shipment—Brighton, Point à Pierre, and Point Fortin.

Exports since 1912 have been as follows:—

	Tons.
1912	17,183
1913	54,618
1914	49,299
1915	57,742
1916	136,000
1917	148,000
1918	182,757

British Guiana.—There have been frequent reports of the existence of petroleum deposits in British Guiana, particularly in the north-west, in the region of the Waini river. Several exploration licences have been granted, but so far as is known no results have been obtained. A detailed geological survey of the area is being carried out.

British Honduras.—Honduras is reported to afford numerous and extensive indications of petroleum on the Caribbean coast line, the most noticeable being at Guare, sixty-six miles south of Puerto Cortez.

AUSTRALASIA.

British North Borneo.—Prospecting licences over 150 square miles in the Belait district of the State of Brunei, and over an exclusive concession comprising the whole of British North Borneo have been granted, and exploratory work is in progress. An area of 440 square miles on the Klias peninsula on the west coast, and the island of Mangalum, is held by the Kuhara Mining Company of Japan. The Kuhara Company are said to have received encouraging reports of a geological examination of the Kudat district, on the north-west coast.

Papua.—In British New Guinea evidences of petroleum occur along a coastal belt some eight to twelve miles wide, from the delta of the Purari river almost to Yule Island, surface indications being dotted over an area of about 1,500 square miles. The principal districts are in the Vailala area—Upoia, Orevi, Aro-Aro, Hohoro and Ekoa, Haiari and Vaiviri, Kiri and Pope. There are two main folds running north-south and east-west, a feature being the existence of small anticlines, which it is thought may merge at depth into single and larger anticlines.

Several wells have been sunk to prove the field, and fair shows of oil have been obtained. Owing, however, to difficulties with the strata, which largely consist of soft mud under considerable pressure, no commercial success has yet been attained.

In 1919 the British and Australian Govern-

ments agreed to co-operate in further examination of this territory.

In late German New Guinea oil indications exist between Eitape and Beaken Bay, the principal being near Amuloi, on a tributary of the Halikemak river, which enters the sea east of Smein village, sixty miles from Eitape and near the village of Matapau, about two miles from the mouth of the Wakip or Tiain river, which enters the sea about forty miles east of Eitape.

A rough survey of this area has shown the principal formations to be alluvial deposits of gravel, sand, and clay, outcrops of hard, slatey clay, and sandstone varying from fine-grained and hard to coarser, running into grits, conglomerates, breccias, and limestone.

The indications near Matapau are the most important, excavations showing the whole surface, sand, and gravels, to be heavily saturated with oil, which appears to be of paraffin base. It is dark brown in colour, a good rust solvent and lubricant, and burns with a reddish flame.

Australia.—Important oil shale deposits exist in Australia, but although efforts have from time to time been made to locate deposits of natural petroleum, no success has yet been attained.

In New South Wales a "kerosene" shale has been found at various geological horizons near Murrurundi, about seventy-five miles north-west of Newcastle, and also near Capertee, about 100 miles north-west of Sydney, on the railway to Mudgee. The yield of picked samples is sometimes as high as 130 gallons per ton of shale, but the average is about 80 gallons per ton. Over 12,000 acres, which are estimated to contain more than 20,000,000 tons of oil shale, have been proved.

An analysis of the oil gave the following results:—

Specific Gravity	1·104
Gasoline	7 per cent.
Kerosene	45 „
Gas Oil	25 „
Residuals	9 „

Commercial production commenced in 1868, when about 17,000 tons of shale were raised. More recent production has been as follows:—

	Tons.
1911	75,104
1912	86,018
1913	16,985
1914	50,049
1915	15,474
1916	17,425
1917	31,661
1918	32,395
1919	10,000 (Estd.)

The Commonwealth Oil Corporation, Ltd., which is the company most largely interested, has been considerably handicapped in its operations, owing to the difficulty of access to its properties and the lack of up-to-date methods of working. This latter deficiency is about to be remedied. The high wages demanded have in recent years also militated against successful working.

Boring for petroleum is being carried out at Glenleigh, Penrith, and a depth of 2,500 feet has been reached. Natural gas and brown oil have been encountered.

In Queensland also test wells have been sunk, although geological reports have hitherto not been favourable to the existence of free petroleum. It is considered by some reports, however, th t the wells have not been sunk deep enough to make the tests conclusive, and further trials are now being carried out at Roma, in the north-east of Maranoa province. Shale deposits occur near Gladstone, Port Curtis province, in the Ipswich District of Moreton province, and near Toowoomba, in Darling Downs province.

Bounties of 2*d.* per gallon on the output of kerosene and 2*s.* 6*d.* per cwt. on paraffin wax have been allowed by the Commonwealth Government. A grant has also been made in New South Wales to assist experiments for the extraction of a motor spirit from Zamia palm. Further, the Commonwealth Government has offered a reward of £10,000 for the discovery of natural oil in commercial quantities in Australia, and a bonus of £5,000 has been offered by the South Australian Government to the person or company that first obtains 100,000 gallons of crude petroleum from a well situated in South Australia, the oil to contain not less than 90 per cent. of products obtainable by distillation.

New Zealand.—Indications of oil have been found in Taranaki Province, North Island. The superficial deposits of audesite lavas and fragmentals and recent sandy debris shroud the sedimentary rocks which consist of claystones, sandstones, and fine conglomerates, ranging probably from Pliocene to Miocene age, for a radius of about ten miles from Moturoa. Beyond this, to the east and north-east of Moturoa, the sedimentary rocks appear at the surface as alternating beds, and are traceable to Mohau, fifty miles from Moturoa, the beds passing downwards, probably conformably, into limestones, claystones, and sandstones, with coal seams. Structurally these rocks seem to

form part of a great monoclinal fold, dipping from Mohau towards Moturoa, with minor cross-wells in the form of anticlines, and synclines of sufficient importance to have influenced the position of subterranean reservoirs of petroleum.

A large number of holes have been drilled to depths of from 2,000 to 5,000 feet, but so far without any commercial success, although oil has been obtained in small quantities. Further efforts are being made to develop the field with Government assistance in the way of payment of wages, of the cost of coal, etc. Operations have also been carried out in the Gisborne and Wairarapa districts, North Island, and at Kotuku and Chertsey, South Island. At Kotuku small flows of oil have been obtained at shallow depths, but so far no wells have given profitable results.

Tasmania.—In the neighbourhood of Latrobe and Railton, county Devon, shale deposits are found of an average thickness of 4 feet, and estimated to contain about 5½ million tons. This shale, which is of a tough, brown, laminated composition, and rich in carbonaceous matter, is peculiar to Tasmania, and is known as "Tasmanite"; its average yield on distillation is about 40 gallons of crude oil per ton. The latter is a heavy, dark olive-green liquid, with a specific gravity varying from ·940 to ·950. It burns readily with a strong luminous flame.

It may not be without interest if I now endeavour to explain how oil is discovered, and how it is found, stored in the bowels of the earth, and at the same time if I say a few words on the history of the industry.

Although petroleum has been known from time immemorial, it is interesting to note that the modern petroleum industry really had its birth in England, in spite of the fact that for generations crude oils have been used for illumination purposes in the East.

It was in 1847 that natural petroleum was first worked on a commercial scale at the Riddings Colliery in the Midlands, not far from the present zone in which test-drilling is being conducted by His Majesty's Government, under the direction of Lord Cowdray. And it was from this oil that illuminating oil was first distilled. Here Young commenced his labours which ultimately established the Scottish shale industry.

In 1859, some twelve years after the working of oil at the Riddings Colliery, the famous Drake Well at Titusville, in Pennsylvania, established the possibility of obtaining oil in commercial quantities by boring; and Drake's success gave birth to the petroleum industry in the United States, which now produces over 50,000,000 tons of oil per annum, out of the total world's production of something over 72,000,000 tons per annum. Prior to 1871, crude oil, except in the East, was used chiefly for medicinal purposes, and was considered an infallible specific for all kinds of ailments.

Rapid Growth of the Industry.

The great oil industry, as we know it to-day, is therefore only some sixty or seventy years of age. The rapidity with which it has advanced, and the numerous uses to which oil and its products have been put, mark an epoch in the advancement of engineering and chemical science, which may almost be claimed to be revolutionary. Before the oil industry came into being, "half the world literally lived in darkness and without any conception of means of transport, as we know it to-day."

Petroleum in the crude state, whether derived from a flowing well or from retort, is a complex mixture of hydro-carbons, only dissimilar in molecular degree from the complex hydro-carbons of which coal is composed. The hydro-carbons which constitute the main bulk of most petroleums belong to what is known as the saturated paraffin series. The first four of this series—starting with methane (CH_4)—are gases; the next three—pentane, hexane, and heptane—are highly volatile liquids constituting the bulk of "petrol." Some petroleums are also included in the olefine series (ethylene C_2H_4).

Petroleums contain certain admixtures of sulphur, nitrogen, and oxygen derivatives in comparatively small proportions, which are more or less impurities, and have to be removed in the treatment of the product for commercial use.

Now, how is this crude oil met with in Nature? Where is it found? How is it prepared and distributed for use?

Being a liquid, natural petroleum is capable of migration within the pores of the containing rock, and of being concentrated within geological boundaries. It is owing to this characteristic that accumulations of crude petroleum on a commercial scale are possible. Given a spongy rock, bedded between two impervious strata, you can readily imagine that oil would slowly percolate by gravity into the lowest parts of the sponge. Doubtless, this is what would happen were it not that these porous zones are also

filled with water, so that instead of the oil finding its way to the lower reaches, it floats on the top of the water, oil being lighter than water, and becomes concentrated or trapped into the upper reaches of whatever space is available. The form of this space depends upon the geological structures; anti-clinal or saddle-back folding being the most common form.

Oil so accumulated is usually under pressure, from which it may be released in the form of flowing wells or spouters when the containing stratum is pierced by a borehole.

The resource and experience of the geologist are necessary to indicate where these deep-seated reservoirs exist, and the skill of the engineer is brought into play in tapping these structures with the drill in such a manner that the pent-up energy is usefully employed in forcing the oil to the surface, and in securing the oil pocket from the influx of water lying in the upper strata, which may ruin what otherwise would be a remunerative deposit of petroleum.

It is not infrequent that surface indications of oil exist along the outcrops, and these indications, such as seepages of gas and oil, mud volcanoes, oil-stained sands, etc., when properly examined, may give useful data as to the potential oil-bearing value of the underlying structures.

After test wells have proved the existence of these underground supplies of oil, systematic drilling is proceeded with, the distance apart of the oil wells being governed by many factors, such as porosity and thickness of the oil beds.

Colossal waste resulted from competitive drilling, owing to each landowner endeavouring to drain as much as possible of the oil pool. Waste has resulted, not only from the number of unnecessary wells and from the failure to provide storage and transport facilities for the valuable product when obtained, but also from the inefficient work done in the scramble for oil. Such panic procedure frequently completely destroys a productive zone by allowing water to gain access to it. It has been estimated that such indiscriminate drilling and inefficient work has resulted in the loss of over 50 per cent. of the potential petroleum production of the United States.

It was on account of this factor that the British Government was led to take steps to regulate the petroleum industry in this country from its inception, and should a petroleum industry be established in the United Kingdom, the wisdom of this policy will be fully demonstrated.

In order that no opportunity should be lost of helping to meet the serious shortage of petroleum products during the war, it was decided that steps should be taken to determine the existence or otherwise of natural petroleum in this country, and Messrs. Pearsons, on behalf of the Government, commenced drilling operations in Derbyshire, Staffordshire and the Midlothian district of Scotland. Of the eleven wells sunk, one only (that at Hardstoft) has so far reached the productive stage; oil being encountered at this well in May 1919, at a depth of 3,077 feet, and the flow of oil has been continuous to date, at the rate of about one ton of oil a day. With regard to the remaining wells, owing to various causes, only one other has at present reached the stage at which evidence, either negative or positive, is forthcoming, but sufficient has already been secured to indicate that the test was fully justified. Indeed, there does not appear much reason to doubt that oil in commercial quantities will be forthcoming in England, but it will take years to develop fully.

TRANSPORT.

When oil comes out of the wells, it is usually run through pipes into storage tanks. The commercial production of oil is dependent upon transportation, which is in most cases accomplished by means of pipe lines, tank ships and tank cars. The storage tanks, which are situated in the oil-fields, and are sometimes called tank farms, are generally connected with the gathering lines (about two inches in diameter) of the pipe line system, through which the oil is conveyed to large storage tanks situated near enormous pumping plants. These draw the oil from the storage reservoirs and drive it under pressure into the main pipe lines (varying from eight inches to 12 inches in diameter); and through these main pipe lines the oil is transported hundreds of miles, intermediate pumping-stations being usually placed at distances of thirty to sixty miles along the main pipe lines. In the United States there are over 100,000 miles of main pipe lines, and they transport approximately 100,000 barrels of crude oil per day with greater facility and at lower freight rates than the oil could be shipped on the railways. The question of pipe lines is a very important matter, because even a producing oil-well is of no commercial value unless it is possible economically by means of convenient transportation to send the oil to market.

Refining.

Crude oil when obtained is subjected to refining processes, and by fractional distillation the various grades of oil known in commerce are secured. These vary from lubricating oil and greases to fuel oil and petrol.

I have endeavoured to show you how far it may be possible to find oil in various parts of the Empire, and how the oil is removed when found, and I am sure you will realise how much it must be the duty of every citizen of this great Empire of ours to stimulate the scientific search and exploitation of areas which, by the geological age and structure, are worthy of examination. I cannot conclude my lecture without paying a tribute to Mr. Walter Long, the First Minister in Charge of Petroleum Department, who piloted the Empire and the Allies in the difficult problems connected with petroleum supplies through the most perilous period of the war, and to Mr. Pretyman, who has been good enough to preside to-day.

Mr. Pretyman was probably the first to see with a statesman's clear vision the coming of the oil age and the need for an Empire Policy on oil. For the past twenty years he has devoted the closest attention to the subject, and has sown seeds, the fruit of which is now being gathered. For his foresight and pioneer work this country and the Empire owe a debt to Mr. Pretyman which cannot be readily measured, but which must not be forgotten.

DISCUSSION.

The Chairman, in opening the discussion, said the author had referred in much too flattering terms to his (Mr. Pretyman's) connection with the question of the use of petroleum by the Navy, which originally arose when he held an official position at the Admiralty at the time the Sea Lords, amongst whom was Lord Fisher, made up their minds that petroleum was to be the fuel for future use in the Navy. As the author had pointed out, the amount of petroleum production in the British Empire was very much below its needs, and it was quite obvious that in war-time the nation could not afford to depend upon outside sources, particularly for the Navy. Every one realised the enormous value which our coal supply had been to the Navy in the past, and if this country was to remain in a pre-eminent naval position it was necessary to secure adequate supplies of fuel of all kinds. He was fortunate enough, when he occupied the position of Civil Lord to the Admiralty, to obtain the assistance and advice of the late Sir Boverton Redwood, through whose great knowledge the Admiralty was able to take advantage of the concession which Mr. D'Arcy had obtained in Persia entirely "on his own" as a private individual. But for the information given to the Admiralty by Sir Boverton Redwood at the time there was a possibility that the control of the Persian oil-fields would have passed into the hands of other nationals; but, fortunately, through Mr. D'Arcy's patriotism and the country waking up in time, that concession came into British hands. Any one who realised the position in which the country was as regards petroleum supplies would have been something less than sane if he had not at that time taken care to devote every possible opportunity at his disposal for the advancement of the interests of the Empire. Difficulties had occurred again and again in connection with the history of the problem. The incidents to which he had referred occurred in 1901 and 1902, and unfortunately some years afterwards the Government of the day was more bent upon economy than upon realising the possible future needs of the country. The position we held was then very nearly lost. By the patriotism of certain private individuals sufficient hold was, however, kept, so that when the position was again realised at headquarters this country was able to maintain the control. That had been of enormous value during the war, and he believed it would be of greater value in the future. No man could measure the possibilities of petroleum discoveries in the future. It was impossible for any one to get up and say that the petroleum supply of the world was always going to be less than the world's requirements, but it could be said that the petroleum in sight at the present time was too little for present-day needs and, that being so, it was obviously vitally important to increase it. This country was interested, not only in the very important subject of the petroleum supply of the world as measured in tons, but in the petroleum supply available in those countries where there was a surplus. Seventy per cent. of the petroleum supplies of the world were in the United States, practically the whole of which was required there and could not be exported to this country. Therefore a much smaller quantity in Persia or Mesopotamia, where the supply was likely to exceed the local requirements, was of more interest to this country than a vast supply elsewhere which would never be available. Consequently, on looking into the matter from the point of view of the needs of the Empire, the Government had concerned themselves mainly with two general sources of supply, one within the Empire itself, which was the best for all concerned because, subject to geographical limitations, it was available both in peace and war, and the other outside the Empire, where there was a surplus over and above the requirements of the country of origin, and where the route

from that country to Great Britain could be adequately protected. From that point of view Persia was most important. The Middle East was not so far from this country, particularly if a pipe-line could be carried from the oil-fields to the Mediterranean, so that transport round Arabia, two or three thousand miles, could be avoided. He believed the Anglo-Persian Oil Company were already taking steps in that direction. The Burmah Oil Company had also been very closely associated with the early efforts that were made to obtain an oil supply for the British Empire, and it was largely due to the patriotism of Lord Strathcona and the technical knowledge and financial assistance of that Company that the Anglo-Persian field had been developed. Lord Strathcona took the presidency of the syndicate which established that field. With regard to the very important controversy that was raging in the Press on the subject of the rights and opportunities of British and American subjects in the development of oil-fields, he thought that so far from the American oil magnates having any complaint against this country, the boot was rather on the other leg. The attitude of the British Government had always been to leave its nationals unsupported, while the Governments of other nations, not excluding the United States, looked after the interests of those who attempted to use their financial resources for developments outside their own countries. Where other Governments were not supporting private enterprise he thought our Government ought not to interfere to give its own nationals an advantage over the rest; but where nationals of another country were being supported by their Government then our nationals should receive similar support from the British Government. The figures showing that the United States possessed 85 per cent. of the world's production, while the British Empire possessed less than 5 per cent., could not be contradicted. He did not think legitimate complaint could, therefore, be made if, in view of the vital need for fuel for the development of the national resources of any nation, this country tried by every legitimate means to extend its 5 per cent. a little further. He was perfectly certain, however, that every Englishman wished for fair play. They remembered how much they had been helped by supplies of oil from the United States during the war, and were duly grateful for them; but after all, in the war every Ally put all its resources into the common stock. America happened to have more petroleum than England, while England had more ships than America, so he did not think there was debt on either side in that way. There was a bond of unity between the two parties, who worked together for the common cause, knowing that every effort must be made in order to win the victory. Now that peace had been brought about and normal developments were recurring, the people of this country were anxious that those territories which were under the control of the British Empire should, as far as possible, be developed by associations which were British; at any rate, that where British enterprise had obtained concessions by ordinary competition the holders of the concessions should not be deprived of them simply because they were British, and because there was now British control over those countries. He congratulated the country on having a Petroleum Executive which could advise the Government of the day at any time on what its petroleum policy ought to be. He had had that object in view for something like twenty years. During his two or three terms of office he had seen that every department of the State had its own separate petroleum policy suited to its own particular departmental requirements at the moment; there was no such thing as a Government policy at all. If the country was to have petroleum it was essential that a competent department should exist with full technical knowledge of the petroleum industry and possessing accurate information in regard to the history of the petroleum world. This country had fallen behind over and over again when it came to negotiations with some other country, simply because it had more goodwill than accurate local knowledge and information. It was necessary that the Government of the day should have at its disposal the most accurate historical, technical and commercial knowledge relating to petroleum in order that it might be in a position to negotiate fairly and honourably, and without a Petroleum Executive which could prevent contests between independent departments it was impossible for this country to have justice done to it by its Government in the vital petroleum matters which concerned it so deeply.

SIR GEORGE T. BEILBY, LL.D., F.R.S., said the author had referred to the fact that, prior to the advent of petroleum sixty years ago, more than half the world was in darkness. The great thing that happened through the discovery of oil, and James Young's showing that it could be distilled from shales, was that a new source of light was provided which could be used in every humble household, and the humble households all over this and many other countries were within a few years in possession of a light which their parents had never dreamed of. That was the main feature of the industry for many years, because neither in Scotland nor in America were the heating and power of the products realised. It was probably when Russia began the development of the great Baku supplies of petroleum that the use of petroleum as a source of power and heat was understood. The Russians, not having suitable coal supplies, proceeded to fire

their steamers on the Volga, and their railway engines with the less volatile part of the natural Baku oil. The rapid changes that had taken place since that time might be ascribed to the increasing appreciation of liquid fuels as a source of power and heat. Their old importance as a source of light for the world had practically gone, but year by year their increasing importance as sources of heat and power had become manifest. During the past year alone the development of public interest in the subject had become almost frantic, but he thought there was an absence of the proper sense of proportion in dealing with it. He did not seek to minimise the immense importance of the nation using every effort to secure the widest possible supplies of natural petroleum, not only during peace, but war, but it was necessary to continue to think in terms of fuel, and if they did so it was impossible to ignore the coal supplies of the world. The world's output of petroleum was at present of the order of 75,000,000 tons per annum, while the world's output of coal was of the order of thousands of millions of tons per annum, so that in all developments of power for transport the greatest attention must be directed to the cheapest form of fuel, namely, coal or coke, and that point required emphasising. It was very encouraging to see on the roads an increasing number of heavy motors and lorries driven by steam engines and gas engines, and development along those lines would go a long way towards reducing the extreme pressure and anxiety which everyone felt owing to the shortage of liquid fuel. The first use of liquid fuel in the form of motor spirit should be for air transport, because at the moment there was nothing to take the place of petrol for transport in the air. In the second place, nothing could take the place of liquid fuel for the Navy, and at present a great danger existed in regard to the supplies for Naval purposes owing to the rapid increase in the requirements of the mercantile marine. In that direction he trusted the authorities would preserve a due sense of proportion, and that every encouragement would be given to the use of the cheapest forms of thermal energy for all kinds of transport for which they were available, because, from what was stated in the paper, it was perfectly certain that there would not be a superfluity of liquid fuel for a long time to come. It was, therefore, a national duty to see that the best advantage was taken of solid fuels, and that all transport that could be run by their aid should be worked in that way.

Mr. A. H. Ashbolt (Agent-General for Tasmania) said that Australia and Tasmania were only infants in oil production, but the question was one of considerable moment to them because the distant parts of the Empire realised the importance of communication with the Old World. The various States had accordingly entered into an agreement with the British Government and the Anglo-Persian interest to erect oil refineries in Australia in the endeavour to make the country partly independent of coal supplies. It was quite possible that at some later date Australia and Tasmania might be self-supporting, but at present they were far from that position. The fact that Australia produced about 10,000 tons of oil fuel per annum was an indication that it possessed potential possibilities as a future supplier of the Empire. Australia covered a territory slightly bigger than the United States of America, and if from its tertiary rocks 10,000 tons of oil fuel were produced per annum, a progressive policy would at a later date help the country to supply not only its own requirements but contribute to the Empire, of which they were proud to be a partner. Mr. D'Arcy, to whom reference had been made, was an Australian, and the fact that his work had been of such considerable benefit to the Empire was a source of gratification to every Australian. Tasmania possessed huge deposits of limestone, and he would be obliged if the author could state whether in his opinion that was an indication that there were big deposits of oil in Tasmania. An endeavour was now being made to introduce capital to develop the shale fields of Northern Tasmania, where it was thought possible that there might be a large supply of oil fuel, although at present its value as a petrol producer was not known. He desired the adoption of an Empire policy in regard to oil which would prevent overlapping of the proper exploration of possible fields for the benefit of the Empire, and he would be glad to know if the Government Department over which the author presided had funds available for exploration in that part of Tasmania in which he (Mr. Ashbolt) was particularly interested.

Dr. W. R. Ormandy emphasised Sir George Beilby's remark that the total oil production of the world was a mere decimal of the amount of coal production, and also joined with him in emphasising the sinfulness of using any oil for mere steam-raising purposes other than in the Navy, and even there only in times of stress. To use oil for steam-raising purposes which could be cracked into more volatile fractions was a scandal. The people in this country had in the past been most reckless and uneconomical users of coal. They were now starting on an oil age, and it was sincerely to be hoped that the same policy of recklessness which had marked the utilisation of coal would not be continued in the case of oil. It was not possible to substitute anything for volatile fuel on a large scale in connection with high-speed internal combustion engines. In so far as volatile fuel could be produced from crude oils it should be produced, because very few people realised that the high-

speed internal combustion engine was the third largest industry of America, and that it would soon be the third largest industry in the manufacturing world. If volatile fuel was too dear or was not available it meant that that third largest industry of the world would be severely damaged and its activities kept down when internal combustion engines were becoming more and more that protean form of developing energy which would replace hand labour, which was growing so expensive that people could not afford to pay for it. He hoped the paper and Sir George Beilby's remarks would penetrate into the last recesses of the Press. Although the Press was perfectly willing to pay a man a large salary to advise as to what was correct or wrong in the Drama, and still larger sums to a clever musical critic, they would not pay a cent to anybody dealing with science, and it was only by papers such as the author's penetrating into the Press that there was the slightest prospect of getting any daylight into the brains of the average British public.

Sir Marcus Samuel, Bt., in proposing a vote of thanks to Sir John Cadman for his illuminating paper and to Mr. Pretyman for presiding, said he was in a somewhat difficult position because he had not always seen eye to eye with the Chairman. He thought the Chairman would agree with him that the public spirit of the eminent men he had mentioned, Lord Strathcona, Sir John Cargill, and the directors of the Burmah Oil Company, would have been able to secure for the British Empire the Persian oil fields they held without the intervention of the British Government. He foresaw what would happen. The moment the British Government as such became traders in petroleum and competed with the companies from which they received large taxation, trouble was bound to occur sooner or later. So soon as the British Government became interested as partners in petroleum other Governments took up the same attitude; and whilst disputes between companies were comparatively unimportant because they soon somehow or other settled their differences, disputes between Governments came under quite a different category. It certainly could not be in the national interest that the jealousy of France and of the United States should be aroused by the British Government being in the trade, when if left to private enterprise no such exception could possibly be taken. He desired to associate himself with the praise which had been bestowed upon Sir John Cadman, who, in the extremely difficult position he occupied of having to reconcile many conflicting interests, had shown himself a man of tact and ability and had rendered the utmost service in his position as Adviser on petroleum subjects. With regard to Mr. Ashbolt's remarks, the association of the Government with the Anglo-Persian Company was most unfortunate, because if Mr. Ashbolt would study the map he would find that the Australian Government had at their disposal oil from British territory, which they might equally have used if they had chosen to do so, which happened to be just half the distance away from Australia that the Anglo-Persian oil-fields were. He put it to Mr. Ashbolt that there was no particular merit in oil that came from a British Protectorate, even if it was produced by the aid of British Government money, when it could be got equally well from another part of the Empire, if it was not held that that oil was tainted because aliens had helped to develop it. For many years to come Great Britain would have to depend upon foreign supplies, and it would be impossible to adopt a more stupid and foolish policy than to alienate the sympathy and take away the assistance which those foreign countries had always rendered to this country. If the unfortunate policy were to prevail that each country could only work oil through its own nationals he was afraid British capital would be in a very perilous state. For instance, if a revolution occurred in Mexico, was it to be said that because the Government changed a concession previously granted should be cancelled, and was it to be said that although there were British concessions in Rumania only the nationals of that country could hold a concession in future? The argument came with infinitely stronger force when they heard that the Government of the United States had decided that if there was not to be reciprocity there should be discrimination in America against countries which discriminated against American citizens. Those were practical considerations which he was sure the author would take care to bring prominently before the Government, because this country could not afford to quarrel with the whole world over the question of oil supply.

Sir Harvey Adamson, K.C.S.I., in seconding the motion, said that some popular fallacies had been knocked on the head by Sir John Cadman's paper, and he was sure everyone was glad to hear that the policy of the Government as advised by the Petroleum Executive, was not quite so bad as they might be led to expect from their perusal of the daily papers.

The resolution of thanks was carried unanimously.

Sir John Cadman, in reply, said he entirely agreed with the remarks Sir George Beilby had made. He had indicated in his paper that there should be no rivalry between oil and coal, but that they should be taken together as a measure of energy, and that coal should be put into a position in which it could be used as economi-

cally as oil. Coal had been used in the past in the most disgraceful way. The time was not far distant when people would not be permitted to burn coal in their fireplaces, but only the residue that was left after the volatile portion had been taken off and passed into commerce to compete with oil. In reply to Mr. Ashbolt's remarks he could only say that sometimes oil was obtained from limestone. It offered inducements for careful examination, and he hoped the Tasmanian Government would not fail to have their territory geologically examined. Sir Marcus Samuel had outlined some of the difficulties connected with the general question. It had been said that the Anglo-Persian Company, owing to the fact that it had a certain amount of Government capital in it, was under the influence and domination of the Government. It was his privilege to act for the Government, and he assured those present that he had no more power over the Anglo-Persian operations than he had over the operations of Sir Marcus Samuel's companies. Some of the points which Sir Marcus had raised might be argued on high political grounds. All he could say was that, during the period he had been in touch with the activities of the oil companies, they had been of the greatest benefit to the country, and he acknowledged the Government's indebtedness to people like Sir Marcus Samuel, Mr. Deterding, Sir Charles Greenway, Lord Cowdray, and others who were running those great organisations. While they were prepared to come to meetings of that character and to discuss in a friendly way certain phases of the question, when it actually came to the point none of them was lacking in his support of the Empire. He made that remark, because it might be thought from what Sir Marcus Samuel had said that there was a feeling somewhere between the interests that ran the different companies. The feeling was only the froth on the surface; they were really out to do business in the great Empire to which they belonged, and they were doing it in the interests of and to the credit of the Empire and themselves.

The meeting then terminated.

THE CHINESE MARKET.

The following information as to the outlook for British trade in China is taken from a special article in the *Board of Trade Journal*:—

As a belligerent China came late into the war (August, 1917), and was not called upon by her allies to take any military part in it. She enjoyed exceptionally good crops during the war years, and the closing of European markets was offset by the expansion in business with Japan and the United States. The years 1916, 1917 and 1918 established records as regards value in China's foreign trade. She was forced, by the pre-occupation of the European Allies, to turn more and more towards Japan, and both her Northern and Southern Governments pledged valuable mining and industrial concessions with that country in return for loans. But this enforced dependence upon Japan had one beneficial effect in that it emphasised, in the minds of the more thoughtful among the Chinese, the contrast between the weakness and backwardness of China and the strength and development of Japan. This glaring contrast between Oriental peoples did much to rouse a small healthy public opinion in China to demand radical reforms in government and to seek after the development of transport and industry. The old anti-foreign feeling is disappearing, and the desire is awakening that China should avail herself of foreign skill and science in the development of the country. The British people have the advantage of belonging to a country which has always pledged itself to maintain China's integrity, and their reputation for just dealing stands very high in the eyes of a race which is pre-eminently honest in its commercial operations. No foreigners have been more successful than the British in establishing friendly personal relations with Chinese customers. We understand them as well as any modern Western people can understand so ancient and proud an Eastern race.

The United States and Japan.

Although there was an inevitable shrinkage in the volume of China's foreign trade during the war the value steadily increased. America is probably the most serious competitor of Great Britain at the present time, for though trade with Japan expanded enormously during the war years, the thorough and persistent boycott of Japanese goods, established in 1919, has dealt a blow from which it will take the trade some time to recover. American business men of all kinds are flowing into China, and over 100 American firms have opened in Shanghai alone during the past year. American banks, shipping companies, land investment companies, and wholesale and retail importers and exporters are all represented. Ninety per cent. of China's imports and exports pass through the ten principal Treaty ports, of which 40 per cent. is claimed by Shanghai. Big British merchant houses have been established in these ports for many years, in some instances for nearly a century, and through their long-established Chinese connections these firms remain —at least for the present—the best channels through which British goods may be sold in China. It is difficult for the new American competitors to rival the big British house, either in the extent of its connections or in its repute for financial stability. Great Britain still possesses the advantage of old connections.

Great Britain's Share in the Trade.

Thus a year's experience of trade after the war shows that Lancashire has definitely and completely re-established the position which the shipping

and other troubles during the war years compelled it to relinquish. Neither Japan nor America has been able to supply rivals to the high-grade dyed and figured cloths of British manufacture, and the moment the Chinese market could look to Lancashire for supplies British piece-goods were eagerly welcomed. The Japanese are making only slow progress against us in dyed cloths. Even in the greys section, including sheetings, shirtings, drills and jeans, upon which our competitors concentrated, British materials have come back into their own. The personal factor counts for much in China, and the British trader who knows and is known in the market retains his pull in spite of a temporary absence. If the year 1919 be considered as a whole and regarded as a test, it is safe to say that British trade is as sound as, if not sounder than, ever. Its qualities of permanence and vitality have been tested and have made good.

Although for the moment Japan has domestic difficulties to contend with, as well as the Chinese boycott to wear down, her competition is a more permanent factor to be faced than that of America. It is fully recognised that Japan's future as a great commercial country depends upon her retention and development of the Chinese market. It is a limitless market, opening out from her very doors. America might withdraw without serious loss; Japan must hold on. There are so many styles of cloth produced by the three countries that active development within China herself may offer scope for all three. Neither America nor Japan can supplant Great Britain; neither can Great Britain wholly supplant them.

The most serious danger for us is the advance in prices. At present the difficulty in securing textile machinery hampers the expansion of China's local spinning and weaving mills. But time will remove this obstacle, and should the reduction in working hours and the advance in costs in Lancashire continue indefinitely there may come a time when British goods will no longer be able to hold their own either against the local products or against those of Japan a d America. During the past year China has been starving for goods and willing to pay almost any price for our products, but the market will not always be starving. We shall then have to compete in prices as well as in quality and style.

The Future of British Trade.

China, the oldest of the world's great markets, is still undeveloped. Her 350 millions of people buy abroad little more than twelve shillings-worth a head. As she develops her internal resources, and more fully utilises her infinite resources in cheap coal and cheap labour, there must be an expansion in her exports and a corresponding expansion in her imports of foreign goods. At the same time it should be recognised that China will become at no distant date an important manufacturing country, and put forth native goods in competition with many of those which are at present imported. It will be well, therefore, for our manufacturers who have a deep interest in retaining the Chinese market, and in sharing in the coming expansion, to consider the establishment of branch factories in China in which to produce those cheaper lines of goods which must in time undersell the corresponding imported articles. China not only has vast coal measures; she produces, or can produce, practically every form of raw material required for industrial and commercial purposes. She is even experimenting with rubber in South China.

Local British Factories.

Several well-known British manufacturers have found it convenient to establish branch factories in Shanghai and other Treaty Ports in order to supply the China market with such articles as soap, candles, cigarettes, etc., which can be made locally as well as and more cheaply than in the United Kingdom, and it is probable that this example will shortly be followed by others. British manufacturers need not fear this competition, since for many years to come these local factories will only be able to turn out goods of inferior quality which will compete more with the Japanese than the British article, and as the country develops and the standard of living rises, a demand will grow up for higher priced goods of better quality. As an illustration, it is reported that the local agent for a well-known firm of soap-makers can sell more of the imported British article than he can of a cheaper soap made in his Shanghai factory.

Demand for Machinery.

This industrial development has naturally created a demand for foreign machinery, which, owing to the cessation of supplies from Europe and latterly from America caused by the war, has now assumed very considerable dimensions. From all parts of China come orders and inquiries for textile machinery, railway material, electric light and power plants, motor cars and lorries, which our engineering firms are unfortunately only able to cope with to a limited extent, as they have difficulty in obtaining fixed quotations and guarantees of delivery from manufacturers in the United Kingdom, who are apparently fully occupied with home orders. This is particularly regrettable, in view of the enormous expansion in the engineering trade of China that is bound to take place within the next few years, and the keen competition on the part of the Americans, Germans and Japanese. It is desirable that home manufacturers, with an eye to the future, should see their way to give priority to some orders at least from China in order to keep British manufactures before the Chinese. It must be remembered that machinery being still comparatively rare in China, each complete equipment of, say, a cotton mill or an electric light plant attracts far more attention than it would in countries where industries are more highly developed, and, indeed, serves as the best of all advertisements for not only the particular maker of the goods, but for the manufacturers of the

maker's country in general. There is, for instance, a rapidly increasing demand for motor cars in Shanghai, Tientsin, Hankow, and other ports, and rich Chinese will pay almost any price for well-known European makes. Yet since the Armistice not one single British car has been sent to Shanghai, although local agents have implored makers to send out a few cars—for which payment would, of course, be made—for advertising purposes. The result is that American cars are literally pouring into the country and selling at fancy prices, and American garages are springing up in all the large cities.

NOTES ON BOOKS.

COMPRESSED AIR POWER. By Albert W. Daw and Zacharias W. Daw. London: Sir Isaac Pitman & Sons, Ltd. 21*s*. net.

During the last twenty-five years great advances have been made in the use of compressed air. It is not only employed to transmit power to distances, but it is also largely used in mines, collieries, engineering works, tunnelling, quarrying, sewage works, chemical works, breweries, etc. Again, it is employed for pneumatic drilling, riveting, etc.; in foundries for cleaning castings and mouldings; on railways for braking trains, and operating switches and signals; by the Post Office for the conveyance of parcels; by engineers for caissons to reach solid rock in under-water excavations; and its application to industrial purposes is constantly developing.

In view of the great and growing importance of the subject, a handbook dealing with the principles of compressed air power on scientific lines is to be warmly welcomed. The authors begin with the atmosphere, describing its composition, pressure, temperature, etc.; the fundamental physics of air and gases are next treated; the compression, expansion, exhaust and flow of air and gases are fully dealt with, formulæ are deduced for making the necessary computations, and practical examples are stated and solved. A special section is devoted to the air lift pump, and the lines on which it should be designed are indicated. Various types of air valves, controls, and receivers for compressors are described and illustrated; information is given as to the washing and filtering of air before it reaches the compressor, and as to the reheating of compressed air before use in the air motor.

UNION TEXTILE FABRICATION. By Roberts Beaumont, M.Sc., M.I.Mech.E. London: Sir Isaac Pitman and Sons, Ltd. 21*s*. net.

Professor Roberts Beaumont is generally recognised as one of our highest authorities on the rapidly developing subject of union textile fabrication. He has a very wide experience of the properties of raw textile materials of all kinds, and their manufacture into woven fabrics. The present volume, therefore, will be found to possess singular interest and value for manufacturers and investigators whether connected with the cotton, the wool, the flax, or the silk trade. It contains a great mass of information which, however, is methodically arranged, and rendered easy for reference, while the 204 illustrations are of great assistance in making clear the meaning of the text.

The book contains many suggestions which should be helpful to those who are endeavouring to produce new cloths. It deals fully with the selection, blending, and preparation of bi-fibred yarns, particularly of wool and cotton and union twist yarns for fancy or piece dyed goods. The section on colourisation and textual toning contains numerous examples, while the use of union twist yarns in combination with single, double, and multiple weave structures is fully described and illustrated. The last part deals with woven unions and simple ornament obtained by various methods of drafting, and by the employment of special weaves adapted to the production of woven fabrics of light structure.

GENERAL NOTES.

PORTUGUESE SALT.—According to the American Consul-General at Lisbon, the annual production of salt in Portugal for export is 150,000 to 200,000 tons. The stocks of 1917 and 1918 are still unsold. Aveiro in the north, Setubal on the river Sado, and the Tagus are the main salt-producing districts in Portugal. The exportation of Portuguese salt before the war was chiefly to the Netherlands, France, Newfoundland, Norway, Sweden, and Ireland. After the war conditions changed; the Netherlands, Sweden and Norway now buy mineral salt from Germany, and France makes its purchases from England. In Norway the importation of salt will be eliminated soon, owing to the building of large electrical sea-water evaporating plants for obtaining salt direct from the sea. The representatives of the Portuguese salt industry have called the attention of the Government to their difficulties.

LONG STAPLE COTTON FOR TYRES.—The United States Department of Agriculture, according to the *Journal of the Textile Institute*, is undertaking a great amount of work in the effort to develop adequate supplies of long-staple cotton for use in motor-car tyre manufacture. A cotton had been brought from Egypt, and, by careful breeding and selection, the specialists had developed a long-staple cotton which was probably the best in the world—one that would add greatly to the life of every fabric made from it. Twenty million dollars worth of that cotton was produced last year in the desert country of the south-west where practically nothing grew before, and the production was expected to increase greatly this year. As the American-Egyptian cotton industry develops, more of the cotton will go into articles other than automobile tyres, and considerable quantities of clothing will be manufactured from it.

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***All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C.* (2)**

PROCEEDINGS OF THE SOCIETY.

SIR GEORGE BIRDWOOD MEMORIAL LECTURE.

A meeting of the Indian Section was held on Friday, June 18th, 1920; THE RIGHT HON. LORD MESTON, K.C.S.I., LL.D., in the chair.

The lecture delivered was—

THE ENDURING POWER OF HINDUISM.

By SIR VALENTINE CHIROL.

I esteem it a very great honour to have been invited to deliver the first of the annual lectures founded by this Society in respectful and affectionate memory of one of its oldest and most distinguished members, the late Sir George Birdwood, whose personal friendship it was my privilege to enjoy. There is, indeed, little I can add to the admirable tribute rendered to him in the Society's *Journal* shortly after his death three years ago. If East and West can meet, they met in the heart of one who was as passionate and understanding a lover of India as of Britain. To the two-fold flame that burnt in him up to the last day of his life I can speak with more authority than to the invaluable work which he did for over forty years as a member of the Royal Society of Arts, or to the wealth of recondite knowledge, combined sometimes with an equal wealth of exuberant imagination which he was always ready to pour forth for the benefit of a less favoured public. The last volume of the great "Life of Lord Beaconsfield," begun by the late Mr. Monypenny and just completed by Mr. Buckle, produces interesting evidence that it was Sir George Birdwood who started in the observance of Primrose Day (but not the Primrose League) the still popular cult of a statesman whom most people would probably have been disposed to associate with some less retiring flower. Mr. Buckle explains the choice of the primrose to commemorate, as it does to the present day, a striking personality which some may still think to have been the greatest, and all will admit to have been the most picturesque figure in the political arena of our times. But the secret of Sir George's fervent admiration for Lord Beaconsfield may, I think, be found in a letter I received from him in the autumn of 1914, when the first Indian Expeditionary Force began to reach the battlefields of France and to fill up the awful gaps in our thin red line, which could not have been otherwise filled before Kitchener's new armies and the contingents from the self-governing Dominions were trained and equipped to follow in the track of our glorious "contemptibles." "India to the rescue," he wrote, "at the call of her Emperor"—with the word Emperor assuredly three times underlined. "And to think there were fools who dared to jeer when Dizzy induced Queen Victoria to proclaim herself Empress of India, and Indian troops were for the first time brought across the black water to Malta." I am quoting from memory, but the labour—and it was always worth it—of deciphering his strange hieroglyphics helped to impress the very words he wrote on one's memory.

It was more than anything else the kindred strain of intuitive understanding for the symbolism in which the Indian mind delights that drew forth his enthusiasm for Lord Beaconsfield. Again and again, during the Great War, he loved to dwell on every incident that showed the heart of India to be in unison with that of the whole Empire, and with his special worship of the Rajputs as the incarnation of Indian chivalry, he seemed to identify all India with the gallant figure of old Sir Pertab Singh, who sought, though he did not find, a hero's death on the stricken fields of France. It has been well said of Sir George Birdwood that "there was nobody quite like him—quaint, crotchety, generous and liberal to a fault, often wise, gener-

ally humorous, frequently eccentric, and especially of late years, inevitably outspoken"—and, I would myself add, a great patriotic soul, whose faith never faltered during the darkest hours of our world-struggle. One may grieve that he did not live to see its victorious issue, but had he seen it, it would hardly have added to the unalterable serenity of mind with which, through good and evil report, he never ceased to believe that it must and would come.

In selecting my subject for this lecture I have been chiefly moved by the desire to find one with which I know that Sir George Birdwood would have been in full sympathy, and I can only crave your indulgence if I cannot bring to bear upon it the breadth and depth of expert knowledge with which he would have approached it. I do not claim, indeed, for a moment to address you as a student, but merely as a layman, who, in the course of inquiries directed mainly to the problems of Indian governance in our own days, has been driven to reflect on the enduring power of that great religious and social system which we call Hinduism as the amalgam that has welded together one-sixth of the human race throughout long centuries of domestic turmoil and foreign domination.

It is not one of the least peculiarities of India that, with a remarkable civilisation of her own which reaches back into remote ages, her early history has only now begun to emerge from the twilight of myths and legends, and cannot even now be traced with any assurance of accuracy nearly as far back as that of other parts of the world which preceded or gave birth to our own much more recent civilisation. The pyramids of Ghizeh and Sakkara, and the monumental temples of Thebes bore ample witness to the greatness of Egyptian civilisation long before the interpretation of her hieroglyphics enabled us to determine its antiquity, and the discovery of its abundant art treasures revealed the high degree of culture to which it reached. Excavations in the valley of the Tigris and Euphrates have yielded an almost equally valuable harvest in regard to Babylonian and Assyrian civilisation, and Cnossos has told us its scarcely less wonderful story. Yet the long line of Pharaohs was coming to an end and Egypt was losing the national independence which she has never once recovered; Nineveh had fallen and Jerusalem was destroyed; Greece and even Rome had already started on their great creative careers before any approximately correct date can be assigned to the stages through which Indian civilisation had passed. India only becomes historical with the establishment of the Sasunaga dynasty in the Gangetic kingdom of Magadha, which centred in what is now Behar, about the year 600 B.C.

As to the state of India before that date, no sort of material evidence has survived, or at any rate has yet been brought to light—no monuments, no inscriptions, no pottery even, in fact, no trace of the handicraft of man; nor any records that can be called in any way historical. Fortunately the darkness which would have been otherwise Cimmerian, is illuminated, though with a partial and often uncertain light, by the wonderful body of sacred literature which has been handed down to our own times in the Vedas and Brahmanas and Upanishads. To none of these books, which have, for the most part, reached us in various recensions often showing considerable discrepancies and obvious later interpolations, is it possible to ascribe any definite date. But in them we undoubtedly possess a genuine key to the religious thought and social conceptions, and even inferentially to the political institutions of the Aryan Hindus through the ages that preceded the emergence of India into history. The Vedic writings constitute the most ancient documents available to illustrate the growth of religious beliefs founded on pure Nature-worship, which translated themselves into a polytheistic and pantheistic idea of the universe and, in spite of many subsequent transformations, are found to contain all the germs of modern Hinduism as we know it to-day—and, indeed, of all the religious thought of India. In the Vedic hymns Nature itself is divine, and their pantheon consists of the deified forces of Nature, worshipped now as Agni, the god of Fire; Soma, the god and the elixir of life; Indra, the god of heaven and the national god of the Aryans; and again, under more abstract forms, such as Prajapati, the lord of creation, Asura, the great spirit, Brahmanaspati, the lord of prayer; and sometimes, again, gathered together into the transcendent majesty of one all-absorbing divinity, such as Varuna, whose pre-eminence almost verges on monotheism. But the general impression left on the Western mind is of a phantastic kaleidoscope, in which hundreds and even thousands of deities, male and female, are constantly waxing and waning and changing places, and proceeding from, and merging their identity in, others through an infinite series of processes, partly material and partly metaphysical, but ever more and more subject to the

inspiration and the purpose of the Brahman, alone versed in the knowledge of the gods, and alone competent to propitiate them by sacrificial rites of increasing intricacy, and by prayers of a rigid formalism that gradually assume the shape of mere incantations.

This is the great change to which the Brahmanas bear witness. They show no marked departure from the theology of the Vedas, though many of the old gods continue to be dethroned either to disappear altogether, or to reappear in new shapes, like Varuna, who turns into a god of night to be worshipped no longer for his beneficence, but to be placated for his cruelty; whilst, on the other hand, Prajapati is raised to the highest throne, with Sun, Air, and Fire in close attendance. What the Brahmanas do show is that the Brahman has acquired the overwhelming authority of a sacerdotal status, not vested merely in the learning of a theologian, but in some special attribute of his blood, and therefore transmissible only from father to son. The Brahman was doubtless helped to this fateful pre-eminence by the modifications which the popular tongue had undergone in the course of time, and as the result more especially of migration from the Punjab to the Gangetic plains. The language of the Vedic hymns had ceased to be understood by the masses, and its interpretation became the monopoly of learned families; and this monopoly, like all others, was used by those who enjoyed it for their own aggrandisement. The dead language became a sacred language, and sacred became the Brahman, who alone possessed the key to it, who alone could recite its sacred texts and perform the rites which they prescribed, and select the prayers which could best meet every distinct and separate emergency in the life of man.

Whilst we can follow in the Brahmanas the growth of a luxuriant theology for the use of the masses which, in so far as it was polytheistic, tended to the infinite multiplication of gods and goddesses and godlings of all types, and in so far as it was pantheistic invested not only men, but beasts and insects and rivers and fountains and trees and stones with some living particle of the divine essence pervading all things; and also the erection on the basis of that theology, of a formidable ritual of which the exclusive exercise and the material benefits were the appanage of the Brahman, we have to turn to a later collection of writings known as the Upanishads for our knowledge of the more abstract speculations out of which Hindu thinkers, not always of the Brahmanical caste, were concurrently evolving the esoteric systems of philosophy that have exercised an immense and abiding influence on the spiritual life of India. There is the same difficulty in assigning definite dates to the Upanishads, though many of the later ones bear the post-mark of the various periods of theological evolution with which they coincided. Only some of the earliest ones are held by many competent authorities to be, in the shape in which they have reached us, anterior to the time when India, as I have said, first becomes historical; but there is no reason to doubt that they represent the progressive evolution into different forms of very ancient germs already present in the Vedas themselves. They abound in the same extravagant eclecticism, leading often to the same confusions and contradictions that Hindu theology presents. The Sankhya Darshana, or system, recognising only a primary material cause from which none but finite beings can proceed, regards the universe and all that exists in it and life itself as a finite illusion of which the end is non-existence, and its philosophic conceptions are atheistic rather than pantheistic. In opposition to it the Vedantic system of mystic pantheism, whilst also seeing in this finite world a mere world of illusion, holds that rescue from it will come to each individual soul after a more or less prolonged series of rebirths, determined for better or for worse by its own spirituality according to the law of Karma, not in non-existence, but in its fusion with God, whose identity with the soul of man is merely temporarily obscured by the world illusion of Maya. Only the inconceivable is real, for it is God, but God dwells in the heart of every man, who, if and when he can realise it and has detached himself from his unworthy because unreal surroundings, is himself God. Akin to Vedantic mysticism is the Yoga system, which teaches extreme asceticism, retirement into solitude, fastings, nudity, mortification of the flesh, profound meditation on unfathomable mysteries and the endless reiteration of magic words and phrases as the means of accelerating that ineffable fusion of God and man. The materialism of the Sankhya and the idealism of the Vedanta combine to provoke the reaction of yet another system, the Mimansa, which stands for the eternal and divine revelation of the Vedas, codifies, so to say, their theology into liturgical laws, admits of no speculation or esoteric interpretation, and seems to subordinate the gods themselves to

the forms of worship that consecrate their existence.

Of all the doctrines that these early speculations evolved, none has had a more enduring influence on Hinduism than that of the long and indeed infinite succession of rebirths through which man is doomed to pass before he reaches the ultimate goal either of non-existence or of absorption into the divine essence. For none has done more to fortify the patriarchal principle which from the earliest times governed the tribal family, and to establish the Hindu conception of the family as it prevails to the present day. For with that curious inconsequence which frequently characterises Hindu thought, even when it professes to be ruled by the sternest logic, the belief that every rebirth is irrevocably determined by the law of Karma, *i.e.*, in accordance with the sum total of man's deeds, good and bad, in earlier existences, is held to be compatible with the belief that the felicity of the dead can only be assured by elaborate rites of worship and sacrifice, which a son alone, or a son's son can take over from his father and properly perform. The ancient *patria potestas* of tribal institutions has been thus prolonged beyond the funeral pyre, and the ancient reverence for the dead which originally found expression in an instinctive worship of the ancestors has been translated into a ceremonial cult of the ancestral manes, which constitutes the primary duty and function of every new head of the family. Hence the Hindu joint family system which keeps the whole property of the family as well as the governance of all its members under the sole control of the head of the family. Hence also the necessity of early marriage, lest death should overtake the Hindu before he has begotten the son upon whose survival the performance of the rites essential, not only to his own future felicity, but to that of all his ancestors depends, and, as an alternative, to mitigate the awful consequences of the default of heirs male of his own body, the introduction of adoption under conditions that secure to the adopted son precisely the same position as a real son would have enjoyed. Hence again the inferiority of woman, whom early marriage tended to place in complete subjection to man. Her chief value was that of a potential breeder of sons. In any case, moreover, she passed on her marriage entirely out of her own family into that of her husband's, and terribly hard was her lot if she were left a widow before having presented her husband with a son. Even if she were left an infant widow of an infant husband and their marriage could not possibly have been consummated, she was doomed to an austere and humiliating life of perpetual widowhood, whilst, on the other hand, if she died, her widowed husband was enjoined to marry again at once unless she had left him a son. To explain away this cruel injustice, her fate was supposed to be due to her own Karma, and to be merely the retribution that had overtaken her for sins committed in a former existence, which condemned her to be born a woman and to die a childless wife, or worse still, to survive as a childless widow. The misfortune of the widowed husband who was left without a son should logically have been imputed in the same way to his own Karma, but it was not. All through life, and in death itself, man was exalted and woman occupied a much lower plane, though in practice this hardship was mitigated for the women who bore sons by the reverence paid to them in their homes, where their force of character and their virtues often gave them a great and recognised ascendancy. However hard the laws that governed the Hindu family might press on individual members, the family itself remained a living organism, united by sacred ties—indeed more than a mere living organism, for the actually living organism was one with that part of it which had already passed away and that which was still awaiting rebirth. It is undoubtedly in the often dignified and beautiful relations which bind the Hindu family together that Hinduism is seen at its best, and the picture which Mr. Bhupendranath Basu gave us of it in his admirable paper some two years ago must still, I am sure, be present to the mind of many of those who are doing me the honour of listening to me now.

Traditional usages, or Smriti were ultimately embodied in codes of law, of which the most famous is that of Manu; and though disfigured by many social servitudes repugnant to the Western mind, they represent a lofty standard of morality based upon a conception of duty, or Dharma, narrowly circumscribed, but solid and practical. Though these codes of law, and notably that of Manu in the form in which we possess them, are of uncertain but probably much later date, they afford us, in conjunction with the vast body of earlier religious and philosophic literature and with a certain amount of scientific literature dealing with astronomy and astrology, with mathematics and specially with geometry, and with grammar and prosody, sufficient materials for appraising, with a fair

measure of accuracy, the stage of progress which the Aryan Hindus had reached in the sixth century, B.C. When the world was young, and they revelled in their recent conquest of a fair portion in it, they delighted to worship the bright gods who had helped them to possess it, and worship and war were the ties that kept their loose tribal organisation together. Out of the primitive conditions of nomadic and pastoral life under the leadership of tribal elders who were both priests and warriors, they gradually passed, after many vicissitudes of peace and war, into more settled forms of agricultural life and developed into distinct and separate polities of varying vitality, but still united by the bond of common religious and social institutions in the face of the indigenous populations whom they drove before them, or reduced into subjection and slowly assimilated as they moved down towards and into the Gangetic plain. As the conditions of life grew more complex, with increasing prosperity and probably longer intervals of peace, differentiation between classes and professions grew more marked. There was time and leisure for thinking as well as for fighting, for contemplation as well as for action. The "bright" gods that Nature had conceived for the early Aryans were fashioned and re-fashioned by speculations already laden with the gloom of melancholy and awesomeness that pervades India. Caste, it may be inferred from the Sanskrit word Varna, which means colour, originally discriminated only between the Aryan conquerors of relatively fair complexion and the darker aborigines they had subdued. It was extended to connote the various stratifications into which Hindu society was settling, and in the stringent rules which governed the constitution of each caste, and the relations between the different castes, the old exclusiveness of tribal customs was perpetuated and intensified.

To the supremacy which the Brahman, as the expounder of the scriptures and of the laws deduced from them, and the ordained dispenser of divine favour, through prayer and sacrifice, was able to arrogate to his own caste, the code of Manu, above all others, bears emphatic witness:

"The very birth of Brahmans is a constant incarnation of Dharma. . . . When a Brahman springs to light he is born above the world, the chief of all creatures, assigned to guard the treasury of duties, religious and civil. Whatever exists in the world is all in effect, though not in form, the wealth of the Brahman, since the Brahman is entitled to it all by his primogeniture and eminence of birth."

Every offence committed by a Brahman involves a relatively slight penalty; every offence committed against him the direst punishment. Next to the Brahman, but far beneath him, is the Kshatria and beneath him again the Vaishyan. The Shudras are the servile caste that exists only to serve the twice-born castes, and above all the Brahman. As Sir William Jones has well said in the preface to the translation which he was the first to make a little more than a century ago of these extraordinarily full and detailed ordinances, they represent a system of combined despotism and priestcraft, both indeed limited by law, but artfully conspiring to give mutual support with mutual checks. But though they abound with minute and childish formalities, though they prescribe ceremonies often ridiculous, though the punishments they enact are partial and fanciful, for some crimes dreadfully cruel, for others reprehensibly slight, though the very morals they lay down, rigid enough on the whole, are in one or two instances, as in the case of light oaths and of pious perjury, dangerously relaxed, one must, nevertheless, admit that, subject to those grave limitations, a spirit of sublime devotion, of benevolence to mankind, and of amiable tenderness to all sentient creatures pervades the whole work, and the style of it has a certain austere majesty that sounds like the language of legislation and extorts a respectful awe. Above all it is well to remember that the ordinances of Manu still constitute to-day the framework of Hindu society, and Brahman judges of the Indian High Courts, who administer our own very different codes, still cling to them in private life and quote them in political controversies as the repositories of inspired wisdom.

It is on this background of tangled religious beliefs and abstruse philosophic speculations and very precise and elaborate laws framed to safeguard the twofold authority of priests and kings, but of the latter always in subordination to the former, that we see a number of small states, amongst which Magadha and Kosala vie for pre-eminence, first assuming historic substance in the sixth century B.C. on the eve of the first great revolt against the whole religious and social system of which I have sought to outline the long and laborious evolution through prehistoric centuries. From that date onwards we shall be on firmer ground. For though, even in much later times, the Hindus have never produced historians in the strict sense of the term, we are

able to call in aid the valuable testimony not only of a few indigenous chronicles, but also of Greek and Chinese and Arab writers and travellers, as well as the authoritative evidence supplied by epigraphy and numismatics; and, though for many centuries still very infrequently, the precious remains of ancient monuments. There will still be many gaps which modern research has so far failed to fill in, but there are henceforth a succession of conspicuous landmarks to show the way; and it is with the help of those landmarks that I propose to follow the rise and fall of Buddhism, than which, I think, no more striking illustration can be found of the marvellous tenacity of Hinduism.

Of these great landmarks, Rajagriha, the King's House, built or rebuilt by King Bimbisara, the fifth monarch of the Saisunaga dynasty of Magadha, appears to be the oldest of which any remains still exist. It lay about forty miles S.S.E. of the modern Patna, and rather less than that N.E. of Buddh Gaya, and the Mahabharata mentions all the five hills which, as the first Chinese pilgrim, Fa-Hien, puts it, "encompass it with a girdle like the walls of a town." It was itself a walled city, and some of the walls, as we can still see them to-day, represent most probably the earliest structure raised in India by human hands that has survived down to our own times. They were no jerry-builders then. Strengthened at sundry points by great square bastions, the walls of Rajagriha measure in places over seventeen feet in width and eleven or twelve feet in height, and they are faced with undressed stones three to five feet in length, without mortar or cement, but carefully fitted and banded together with a core of smaller blocks not less carefully laid and packed. They merely supplemented and completed the natural line of defences provided by the outer girdle of hills, rising to 1,200 feet, which shut off Rajagriha from the plain of Bihar. I visited Rajagriha about fifteen years ago as the guest of Sir John Marshall, the Director-General of Archæology, who was then exploring the long since deserted site, and on one of those peerless days of the cold season in Upper India when there is not a cloud to break the serenity of the deep blue sky, I looked up to the mountain Ghridrakuta, on whose slopes Buddha dwelt for some time after he had found enlightenment at Buddh Gaya, and saw it just as the second Chinese pilgrim to whom we owe most of our knowledge of Rajagriha described it—"a solitary peak rising to a great height on which vultures make their abode." Many had been the revolutions of the wheel of time since Hiuen-Tsang had watched the circling of the vultures round the sacred peak some twelve and a half centuries before me, and as Buddha himself, another twelve and a half centuries earlier, had watched them when he miraculously stretched forth his hand through a great rock to rescue his beloved disciple Ananda from the clutch of the demon Mara, who had taken on the shape of a vulture. The swoop of those great birds seemed to invest the whole scene with a new and living reality. Across the intervening centuries I could follow King Bimbisara proceeding along the causeway of rough, undressed stones, which can be traced to-day to the foot of the mountain and up its rocky flanks, after his men had "levelled the valley and spanned the precipices, and with the stones had made a staircase about ten paces wide," so that he should himself be carried up to wait in his own royal person on the Lord Buddha. There, marked to the present day by the remains of two large stupas, was the place where the king alighted from his litter to go forward on foot, and further up again the spot where he dismissed his followers and went on alone to invite the Buddha to come down and dwell in his capital.

That must have been about 500 B.C., and Buddha spent thereafter a considerable portion of his time in the bamboo garden which King Bimbisara presented to him on the outskirts of Rajagriha. There, and in his annual wanderings through the country, he delivered to the poor and to the rich, to the Brahman and to the sinner, to princes and peasants, to women as well as to men, his message of spiritual and social deliverance from the thraldom of the flesh and from the tyranny of caste.

With the actual doctrines of Buddhism I do not propose to deal. There is nothing in them that could not be reconciled with those of the Vedanta, and they are especially closely akin to the Sankhya system. But the distinctive feature of Buddhism, as also of Jainism, which grew up at the same time as Buddhism under the inspiration of another great reformer, Mahavira, who is said to have been a cousin of King Bimbisara, is the social catholicity of its appeal to all classes and castes, and to women as well as to men. The Vedanta reserved the study of the scriptures to men of the three twice-born castes, and placed it under the supreme authority of the Brahmans. Both Buddha and Mahavira recognised no such restrictions, though they did not refuse reverence to the Brahman as a man of special learning. The religious orders which they founded were

open to all, and these orders included nuns as well as monks. This was the rock on which they split with Hinduism. This was the social revolution that, in spite of the religious and philosophical elasticity of the Vedanta, made Buddhists and Jains unpardonable heretics in the eyes of the Brahmans, and produced a conflict which was to last for centuries.

Though King Bimbisara welcomed the Buddha to his capital, and Buddhism made rapid headway amongst the masses, he does not appear to have himself embraced the new religion, and it is not till after Alexander the Great's expedition had for the first time brought an European conqueror on to Indian soil, and the Mauryan dynasty had succeeded that of Saisunaga and transferred the seat of government to Pataliputra, the modern Patna, on the Ganges, that perhaps the greatest of Indian rulers, the Emperor Asoka, who reigned from 272 to *circa* 232 B.C., made Buddhism the state religion of his Empire. Tradition has it, that when Buddha on his last wanderings passed by the fort which King Ajatasatni was building at Pataliputra, he prophesied for it a great and glorious future. It had already fulfilled that prophecy when the Greek Ambassador, Megasthenes, visited it in 303 B.C. Of that second great landmark in Indian history, a few remains are being laboriously rescued from the waters of the Ganges, under which Pataliputra is for the most part buried. But at that time it spread for ten miles along the river front; five hundred and seventy towers crowned its walls, which were pierced by sixty-four gates, and the total circumference of the city was twenty-four miles. The palace rivalled those of the Kings of Persia, and a striking topographical similarity has been lately traced between the artificial features of the layout of Pataliputra and the natural features of Persepolis, King Darius's capital in Southern Persia.

Pataliputra became the capital of India under Chandragupta Maurya, who, soldier of fortune and usurper that he was, transformed the small kingdom of Magadha into a mighty empire. Known to Greek historians as Sandrokottos, young Chandragupta had been in Alexander's camp on the Indus, and had even, it is said, offered his services to the Macedonian king. In the confusion which followed Alexander's death, he had raised an army with which he fell on the Macedonian frontier garrisons, and then, flushed with victory, turned upon the King of Magadha, whom he dethroned. After eighteen years of constant fighting he had extended his frontiers to the Hindu Kush in the north, and nearly down to the latitude of Madras in the south. He had, at the same time, established a remarkable system of both civil and military administration by which he was able to consolidate his vast conquests. His war office was scientifically divided into six boards for maintaining and supplying his huge fighting force of 600,000 infantry, 30,000 cavalry, 9,000 elephants, and 8,000 war chariots, besides fully equipped transport and commissariat services. No less scientific was the system of civil government as illustrated by the municipal institutions of Pataliputra. There, again, there were six boards dealing respectively with trade, industries, wages, local taxation, the control of foreign residents and visitors, and, perhaps most extraordinary of all, with vital statistics. Equally admirable was the solicitude displayed for agriculture, then, as now, the greatest of Indian industries, and for its handmaid, irrigation. The people themselves, if we may believe Megasthenes, were a model people well worthy of a model government, though if he does not exaggerate, one is driven to wonder at the necessity for such fearful penalties as were inflicted for the most trivial breaches of the law. But behind Chandragupta the power of the Brahman was still clearly entrenched, for his chief minister was a Brahman, Chanakya, who had followed his fortunes from their first adventurous beginnings.

The stately fabric which Chandragupta built up during his own twenty-five years' reign, *circa* 322–297 B.C., endured during the reign of his son Bendusara, of whom scarcely anything is known, and at the end of another twenty-five years passed on, undiminished, to his great successor, Asoka, whose unique experiment would have been scarcely possible had he not succeeded to an empire already firmly consolidated at home and abroad. When he came to the throne, about 272 B.C., Asoka had served his apprenticeship in the art of government as viceroy, first in the north at Taxila, and then in the west at Ujjain. He had been brought up by Brahmans in the manner befitting his rank. Buddhist tradition would have us believe that until his conversion he was a monster of cruelty; but there is scarcely enough to warrant that indictment in the fact that he began his reign with a war of aggression, for which he afterwards expressed the deepest remorse. It was, indeed, from that moment that he determined to be henceforth a prince of peace; but it is quite as probable that his determination inclined him

more and more to turn his ear to Buddhist teaching as that Buddhist teaching prompted his determination.

No monarch has ever recorded the laws which he gave to his people in such imperishable shape. They are to be seen to the present day cut into granite pillars or chiselled into the face of the living rock in almost every part of what was then the Empire of the Mauryas, from the Peshawar district in the north to Mysore and the Madras Presidency in the south, from the Kathiawar Peninsula in the west to the Bay of Bengal in the east. The pillars are often at the same time monuments of artistic design and workmanship, as, above all, the Garnath pillar near Benares with its magnificent capital of the well-known Persepolitan type and its four lions supporting the stone Wheel of the Law, first promulgated on that spot. Many more of Asoka's monuments may yet be discovered, but the eleven pillar edicts and the fourteen rock edicts, not to speak of minor inscriptions already brought to light and deciphered, constitute a body of laws which well deserve to have been made thus imperishable. For no temporal sovereign has ever legislated so fully and exclusively and with such evident conviction for the spiritual advancement and moral elevation of his people. Scarcely less important is the autobiographical value of these inscriptions, which enable one to follow stage by stage the evolution of the Apostle-Emperor's soul. Within a year of the conquest of the Kalinjas, for which he afterwards publicly recorded his remorse, Asoka became a lay disciple of the Buddhist law, and two and a half years later studied as a Buddhist monk. In 257 B.C., the thirteenth year of his reign, he began to preach his series of sermons in stone—sermons that were at the same time laws given to his Empire. His profession of faith was as lofty as it was simple :—

"The gods who were regarded as true all over India have been shown to be untrue. For the fruit of exertion is not to be attained by a great man only, because even by the small man who chooses to exert himself immense heavenly bliss may be won. . . . Father and mother must be hearkened to. Similarly, respect for living creatures must be firmly established. Truth must be spoken. These are the virtues of the law of piety which must be practised. . . . In it are included proper treatment of slaves and servants, honour to teachers, gentleness towards living creatures, and liberality towards ascetics and Brahmans. . . . All men are my children, and just as I desire for my children that they may enjoy every kind of prosperity and happiness in both this world and the next, so I desire the same for all men."

These principles are applied in all the instructions to his officials. He commends to their special care the primitive jungle folk and the untamed people of the borderlands. He bestows much thought on the alleviation of human suffering, and his injunctions in restriction of the slaughter and maiming of animals and the preservation of life are minute and precise. It is in this connection that the influence of Buddhism on Hinduism was most permanent, for whilst the primitive Aryan Hindus were beef eaters, their descendants carried the vegetarian doctrines of Buddhism to the extreme length of condemning cow-killing as the most awful of crimes, next to the killing of a Brahman.

Determined to preserve the unity and discipline of his own church, Asoka's large tolerance sees some good in all creeds. He wishes every man to have the reading of his own scriptures, and whilst reserving his most lavish gifts for Buddhist shrines and monasteries, he does not deny his benefactions to Brahmans and ascetics of other sects. Nor is he content merely to preach and issue orders. His monastic vows, though they lead him to forswear the amusements and even the field sports which had been his youthful pastimes, do not involve the severance of all worldly ties. He is the indefatigable and supreme head of the Church; he visits in solemn pilgrimage all the holy places hallowed by the memory of Buddha, and endows shrines and monasteries and convents with princely munificence; he convenes at Pataliputra a great Buddhist council for combating heresy. But he remains the indefatigable and supreme head of the State. "I am never fully satisfied with my efforts and my dispatch of business. Work I must for the welfare of all, and the root of the matter is in effort." He controls a highly-trained bureaucracy not unlike that of British India to-day, and his system of government is wonderfully effective so long as it is informed by his untiring energy and singular loftiness of purpose.

With Asoka Buddhism attained to a supremacy in India which may well be compared with that of Christianity in Europe under Constantine; and it is only, I think, by measuring the height to which Buddhism had then risen that we can realise the enduring power of Hinduism, as we see it through suc-

cessive centuries slowly and steadily but relentlessly recovering all the ground it had lost until Buddhism at last disappears almost entirely off the face of India, whereas it continued to spread, though often in very debased forms, over the greater part of Eastern Asia, and still maintains its hold there over more than a third of the total population of the globe.

As with most of the great rulers and conquerors that India has from time to time thrown up, Asoka's life-work fell to pieces almost as soon as he had passed away. Not only did the temporal empire which he built up disintegrate rapidly in the hands of his feeble successors, but Buddhism itself was dethroned within fifty years with the last of his dynasty, slain by the usurper Pushyamitra Sunga, who, after consecrating himself to the Hindu gods with the rites of Rajasuya, celebrated his advent to paramount power by reviving the ancient ceremony of Asvamedha, the sacrifice of the horse—one of the most characteristic of Brahmanical rites.

When we reach our next landmark at Purushpura, which became in the first century of our era the capital, situated close to the modern Peshawar, of a new dynasty of Kushan conquerors from Central Asia, we indeed find the greatest of them, Kanishka, shedding a transient gleam of glory over the decline of Buddhism, but of a Buddhism already far removed from the purity of Asoka's reign. The most striking feature of this short-lived revival of Buddhism, is the artistic inspiration which it derived from Hellenistic sources, of which the museums of Peshawar and Lahore contain so many remarkable illustrations. The idea, at one time very widely entertained, that Alexander's meteoric appearance in India left any permanent mark on Indian civilisation, is now entirely discarded by the best authorities. No Indian author makes even the faintest allusion to him, nor is there any trace of Hellenic influence in the evolution of Indian society, or in the elaborate institutions with which India was endowed by the Mauryan dynasty that followed immediately on the disruption of Alexander's empire. But the Kushans, or Yueh Chis, who, during the various stages of their slow migration down into Northern India, came into long and close contact with the Indo-Bactrian and Indo-Parthian kingdoms, carved out of Alexander's dominions. The populations were never Hellenized, but their rulers were to some extent the heirs, albeit hybrid heirs, to Greek civilisation. They spoke Greek and worshipped at Greek shrines, and as they were in turn subjugated by the forbears of the Kushan Empire, they imparted to the victors something of their own Greek veneer. In the second century of our era, Kanishka carried his victorious arms down to the Gangetic plain, where Bhuddism still held its own in the region which had been its cradle; and, according to one tradition, he carried off from Pataliputra a famous Buddhist saint, who converted him to Buddhism. But as these Indo-Scythian kings had not been long enough in India to secure admission to the social aristocracy of Hinduism by that slow process of naturalisation to which so many ruling races have owed their Kshatrya pedigrees, Kanishka, having himself no claim to caste, may well have preferred for reasons of state to favour Buddhism as a creed fundamentally opposed to caste distinctions. Whatever the motives of his conversion, we have it on the authority of Hiuen-Tsang, that he ultimately did great things for Buddhism, and the magnificent stupa, which he erected outside his capital, five and twenty stories high and crowned with a cupola of diamonds, was still 150 feet high and measured a quarter of a mile in circumference when the Chinese pilgrim visited Purushpura five centuries later. To the present day there are traces outside the northern gate of Peshawar of a great Buddhist monastery, also built by Kanishka, which remained a seat of Buddhist learning until it was destroyed by Mohammedan invaders, and it was only a mile from Peshawar that the American Sanskritist, Dr. Spooner, discovered ten years ago the casket containing some of Buddha's bones, which is one of the most perfect specimens of Græco-Buddhist art. The Buddhist statues and bas-reliefs of that period are Greek rather than Indian in their treatment of sacred history, and even the head of Gautama himself might sometimes be taken almost for that of a young Greek god.

These exotic influences may indeed have acted as a further solvent upon Buddhism. But in any case, its local and temporary revival as a dominant state religion under Kanishka, whose empire did not long outlive him, failed to arrest its steady resorption into Hinduism. On the one hand Buddhism itself was losing much of its original purity. The miraculous legends with which the life of Buddha was gradually invested, the almost idolatrous worship paid to him, the belief that he himself was but the last of many incarnations in which the Buddha had already revealed himself from the very beginning of creation—all these later

accretions represent, no doubt, the reaction upon Buddhism of its Hinduistic surroundings. But they doubtless helped also to stimulate the growth of the more definite forms of anthropomorphism which characterised the development of Hinduism when the ancient ritual and the more impersonal gods of the Vedas and of the Brahmanas gave way to the cult of such very personal gods as Shiva and Vishnu, with their feminine counterparts, Kali and Lakshmi, and ultimately to the evolution of still more popular deities, some, like Skanda and the elephant-headed Ganesh, closely connected with Shiva; others like Krishna and Rama, *avātaras* or incarnations—and in many ways extremely human incarnations—of Vishnu. At the same time, the Aryan Hindus, as they came to subdue the numerous aboriginal races of India, constantly facilitated their assimilation by the more or less direct adoption of their primitive deities and religious customs. The two great epics, the Mahabharata, with its wonderful episode, the Baghavad-Ghita, which is the apotheosis of Krishna, and the Ramayana, which tells the story of Rama, show the infusion into Hinduism of a distinctly national spirit in direct opposition to the almost international catholicity to which Buddhism owes the facility with which it adapted itself to the political aspirations of non-Hindu conquerors as well as of non-Hindu races beyond the borders of Hindustan, in Nepal and in Ceylon, in Burma and in Tibet, in China and in Japan. Thus the conflict between Buddhist and Hindu theology might not have been irreconcilable, for Hinduism, as we know, was quite ready to admit Buddha himself into the privileged circle of its own gods as one of the avatars of Vishnu. What was irreconcilable was the conflict between a social system based on Brahmanical supremacy and one that denied it—especially when Hinduism introduced into it an element of nationalism. It is, therefore, not surprising to find this element conspicuous when from another long period of darkness which followed the downfall of the Kushan kingdom, Indian history emerges into the splendour of what has been called "the golden age of Hinduism" in the fourth and fifth centuries of our era under the great Gupta dynasty, who ruled at Ujjain.

Few Indian cities are reputed to be more ancient or more sacred than the little town of Ujjain on the Sipra river, known as Ozenī to the Greeks, and where Asoka had ruled in his youth as Viceroy of Western India. It owes its birth to the gods themselves. When Uma wedded Shiva, her father slighted him, not knowing who he was, for the mighty god had wooed and won her under the disguise of a mere ascetic mendicant, and she made atonement by casting herself into the sacrificial fire, which consumed her, the prototype of all pious Hindu widows who perform Sati, in the presence of gods and Brahmans. Shiva, maddened with grief, gathered up the bones of his unfortunate consort and danced about with them in a world-shaking frenzy. Her scattered bones fell to earth, and wherever they fell, the spot became sacred and a temple sprang up in her honour. One of her elbows fell on the banks of the Sipra at Ujjain, and few shrines enjoy greater or more wide-spread fame than the great temple of Maha-Kal, consecrated to her worship and that of Shiva. Its wealth was fabulous when it was looted and destroyed by Altamsh and his Pathan Mohammedans in 1235. The present buildings are for the most part barely 200 years old, and remarkable chiefly for the insistency with which the lingam and the bull, the favourite symbols of Shiva, repeat themselves in shrine after shrine. But it attracts immense numbers of pilgrims, especially in every twelfth year, when they flock in hundreds of thousands to Ujjain and camp as near as possible to the river. The peculiarity of the Ujjain festival is that, in memory of the form which Shiva took on when he wooed Uma, it attracts a veritable army of Sanyasis, or mendicants, sometimes as many as fifty thousand, from all parts of India. Seldom, except at the great Jaganath festivals at Puri, is a larger congregation seen of weird and almost inhuman figures, some clothed solely with their long, unkempt hair, some with their bodies smeared all over with white ashes and the symbol of their favourite deity painted conspicuously on their foreheads, some displaying ugly sores or withered limbs as evidence of lifelong mortification of the flesh, some moving as if in a dream and entirely lost to the world's realities; some with frenzied eyes shouting and brandishing their instruments of self-torture, some with a repulsive leer and heavy, sensuous jowls affecting a certain coquetry in the ritualistic adornment of their well-fed bodies.

Chandragupta I., the founder of the great dynasty which Hindus extol over all others, was only a petty chieftain by birth, but he was fortunate enough to wed a lady of high lineage, who could trace a connection with the ancient Maurya house of Magadha, and, thanks to this alliance and to his own prowess, he was able at his death to bequeath real kingship to his son,

Samadragupta, who, during a fifty years' reign, 326–375 A.D., again welded almost the whole of India north of the Nerbudda river into one empire, and once even spoiled Southern India right down to Cape Comorin. His victories are recorded—with an irony perhaps not wholly accidental—beneath the Asokan inscription on the Allahabad pillar. Of his zeal for Hinduism we have a convincing proof in gold coins of his reign that preserve on the obverse in the figure of the sacrificial horse a record of the Asvamedha, which he again revived. Strange to say, however, his fame has never been so popular as that of his son, Chandragupta II., Vikramadytia, the Sun of Power, who reigned in turn for nearly forty years, and has lived in Hindu legend as the Raja Bikram, to whom India owes her golden age. It was his court at Ujjain which is believed to have been adorned by the "Nine Gems" of Sanskrit literature, amongst whom the favourite is Kalidasa, the poet and dramatist. Amidst much that is speculative, one thing is certain. The age of Vikramadytia was an age of Brahmanical ascendancy. As has so often happened, and is still happening in India to-day in the struggle between Urdu and Hindi, the battle of religious and political supremacy was largely one of language. During the centuries of Brahmanical depression that preceded the Gupta dynasty, the more vulgar tongue spoken of the people prevailed. Under the Guptas, Sanskrit, which was the language of the Brahmans, resumed its pre-eminence and took possession of the whole field of literature and art and science as well as of theology. Oral traditions were reduced to writing and poetry was adapted to both sacred and profane uses in the Puranas, in the metrical code of Manu, in treatises on sacrificial ritual, in Kalidasa's plays, and in many other works of which only fragments have survived. Astronomy, logic, philosophy, were all cultivated with equal fervour and to the greater glory of Brahmanism. Local tradition is doubtless quite wrong in assigning to Raja Bikram the noble gateway which is the only monument of Hindu architecture at its best that Ujjain has to show to-day. But to that period may, perhaps, be traced the graceful, if highly ornate, style of architecture, of which the Bhuvaneshwar temples, several centuries more recent, are the earliest examples that can be at all accurately dated. To the credit of Brahmanism be it said that in its hour of triumph it remained at least negatively tolerant, as all purely Indian creeds generally have been. Fa-Hien, who visited India during the reign of Vikramadytia, though dismayed at the desolation which had already overtaken many of the sacred places of Buddhism, pays a generous tribute to the tolerance and statesmanship of that great sovereign. The country seems, indeed, to have enjoyed considerable prosperity under a paternal and almost model administration.

Yet the Gupta dynasty endured only a little longer than had that of the Mauryas. Its downfall was hastened by the long reign of terror which India went through during the invasion of the White Huns. Europe had undergone a like ordeal nearly a century earlier, for when the Huns began to move out of the steppes of Eastern Asia they poured forth in two separate streams, one of which swept into Eastern Europe, whilst the other flowed more slowly towards Persia and India. What Attila had been to Europe, Mihiragula was to India, and though the domination of the Huns did not long outlive him, the anarchy they left behind them continued for another century, until "the land of Kuru," the cradle and battle-field of so many legendary heroes, produced another heroic figure, who, as King Harsha, filled for more than forty years (606–648) the stage of Indian history with his exploits. He had inherited the blood of the Gupta emperors from his mother, though his father was only a small Raja, of Thanesvar, to the north of Delhi; the tragic circumstances in which he succeeded him made a man of him at the early age of fourteen. By the time he was twenty he was "master of the five Indias"—*i.e.*, of nearly the whole of Northern India from Kathiawar to the delta of the Ganges, and henceforth he proved himself as great in peace as in war. In his case the knowledge we owe to Chinese sources is supplemented by the valuable record left by the Brahman, Bana, who lived at his court and wrote the Harsha-Charita. Taxation, we are told, was lightened and the assessment of land revenue was equitable and moderate. Security for life and property was enforced under severe but effective penalties. Education received impartial encouragement whether conducted by Brahmans or by Buddhist monks, and both as a patron of literature, which he himself cultivated by composing dramas, and as a philanthropic ruler, King Harsha bestowed his favours with a fairly equal hand on Hinduism and on Buddhism alike. For Buddhism still lingered in the land, and Harsha, who was a mystic and a dreamer, as well as a man of action, certainly inclined during his later years towards Buddhism,

or, at least, included it in his own eclectic creed.

Hiuen-Tsang, who spent fifteen years in India during Harsha's reign, searching for the relics of early Buddhism in a land from which it was steadily disappearing, has given us a wonderful picture of a religious state-pageant which makes Prayaga, at the triple confluence of the Ganges and the Jumna with the sacred but invisible river, Saraswati, near to the modern city of Allahabad, stand out as another striking landmark in Indian history. Hindus attach great holiness to rivers and their confluence, and this Triveni, or triple confluence, had been specially consecrated by Brahma, who chose that spot for the first Asvamedha. "From ancient times," says the Chinese chronicler, "the kings used to go there to distribute alms, and hence it was known as the Place of Almsgiving. According to tradition more merit is gained by giving one piece of money there than one hundred thousand elsewhere." So King Harsha, having invited all alike, whether "followers of the law or heretics, the ascetics and the poor, the orphans and the helpless," the kings of eighteen subordinate kingdoms assembled there with their people to the number of 500,000, and found immense refectories laid out for their refreshment and long rows of warehouses to receive silk and cotton garments and gold and silver coins for distribution to them. "The first day a statue of Buddha was placed in the shrine erected on the Place of Almsgiving, and there was a distribution of the most precious things and of the garments of greatest value, whilst exquisite viands were served and flowers scattered to the sound of harmonious music. Then all retired to their resting-places. On the second day a statue of the Sun-god was placed in the shrine, and on the third day the statue of Shiva," and the distribution of gifts continued on those days and day after day for a period of over two months, ten thousand Brahmans receiving the lion's share, until, having exhausted all his wealth, even to the jewels and garments he was wearing, King Harsha borrowed a coarse and much-worn garment, and having "adored the Buddhas of the ten countries," he gave vent to his pious delight, exclaiming: "Whilst I was amassing all this wealth I was always afraid lest I should find no safe and secret place to stow it away. Now that I have deposited it by almsgiving in the Field of Happiness I know that it is for ever in safety. I pray that in my future lives I may amass in like manner great treasures and give them away in alms so as to obtain the ten divine faculties in all their plenitude."

Here one sees India as it was before the Mohammedan invasions, in the days of the last of the great Indian rulers who succeeded for a time in bending the whole of Northern India to his will. As always in India, behind whatever form of temporal power may for the moment appear to be paramount, religion and the social order which it consecrates, represent the real paramount power that alone endures. In this extraordinary festival which marked the close of Harsha's reign the picture left to us is singularly complete. The first day is a sort of farewell tribute to the waning glory of Buddha, and the second to the ancient majesty of the Vedic gods; but they only prepare the way for the culminating worship, on the third day, of the terrific figure of Shiva, who had already been raised to one of the highest, if not the highest, throne in the Hindu pantheon, which he still retains—Shiva, the master of life and death, whose favourite emblem is the phallus, and from whose third eye bursts forth the flame which is one day to consume the world. Around him are the Brahmans and the ascetics, who devour the gifts of Harsha until, at the end of two months, they are wholly exhausted, just as they continue to the present time to live on the gifts of the Hindu peoples, and through them indirectly on the gifts of the British *raj*, which has secured to the Hindu peoples a measure of prosperity they never enjoyed in the days even of King Harsha.

Shortly after Harsha's death in 648 A.D., India, as is her wont as soon as the strong man's arm is paralysed, relapses once more into political chaos. Her history does not indeed ever again recede into the complete obscurity of earlier ages. We get glimpses of successive kingdoms and dynasties rising and again falling in Southern India, as the Hindu Aryans gradually permeate and subdue the older Dravidian races and absorb the greater part of them, not without being in turn influenced by them, into their own religious and social system. Time does not allow me to follow their growth and their decline. I will only mention that it was in the south of India that the last great Hindu kingdom, that of Vijayanagar, whose splendid ruins still line the banks of the Tungabhadra River, in the Bellary district of the Madras Presidency, survived until the middle of the sixteenth century, when it fell at Talikot (January 23rd, 1565) before the fierce onrush of Islam. But the flowing tide of Islam spent itself on that

stricken field, and as Southern India never remained so completely under the heel of the Mohammedan conquerors, it is there that we still have to look for the most imposing monuments of Hindu architecture and for the most characteristic manifestations of Brahmanical supremacy in Hindu society. But I must pass them by, as it is not in Southern India that the enduring power of Hinduism has ever been subjected to the supreme tests which it has undergone in the north.

It was during Harsha's reign that militant Islam first set foot in India, in a remote part of the peninsula. Just at the same time as the Arabs, in the first flush of victory, poured into Egypt, a small force crossed the Arabian Sea and entered Baluchistan, and a century later the whole of Sind passed into Arab hands. But those happenings were too distant to produce more than a local impression, and the most notable feature of the post-Harsha period is the emergence of the Rajput states, whose rulers, though probably descendants of relatively recent invaders, not only became rapidly Hinduised, but secured relatively prompt admission to the rank of Kshatryas in the Hindu caste system, with pedigrees dated back to the Sun and Moon, which to the popular mind were well justified by their warlike prowess and splendid chivalry. I need only recall the name of Prithvi-Raja, the lord of Sambhar, Delhi, and Ajmer, whose epic fame rests not less on his abduction of the Kanauj princess who loved him than on his gallant losing fight against the Mohammedan invaders. By that time, *i.e.*, by the end of the twelfth century, the Mohammedan flood was pouring irresistibly into India, no longer across the Arabian Sea, but from Central Asia through the great northern passes. The first irruption under Mahmud Ghasni, in the year 1002, had been merely the precursor of the more formidable invasions which were to follow in quick succession, until Sultan Baber completed the conquest of Hindustan and founded the Moghul Empire in the early part of the sixteenth century, out of the ruins of which the British Empire of India was in turn to grow up.

Now if we look back upon the fifteen centuries of Indian history, before the great Mohammedan invasions, of which I have tried to reconstitute the chief landmarks, the two salient features that seem to me to emerge from the twilight, are the failure of the Aryan Hindus to achieve any permanent form of political unity or stability and their success, on the other hand, in building up on adamantine foundations a complex but vital social system. The Mauryan and the Gupta dynasties succumbed as irretrievably to the centrifugal forces of petty states and clans perpetually warring against one another, as the more ephemeral kingdoms of Kanishka and Harsha. Buddhism, in spite of its tremendous uplift in the days of Asoka and the intermittent favours it enjoyed under later and lesser monarchs, was already moribund in India before the Mohammedans gave it its final death-blow. Jainism, contemporary with and closely akin to Buddhism, never rose to the same pre-eminence, and perhaps for that very reason secured a longer though more obscure lease of life, and still survives as a respectable but numerically quite unimportant sect. The supple and subtle forces of Hinduism alone welded together the discordant beliefs and customs of a vast variety of races into a comprehensive fabric sufficiently elastic to shelter most of the indigenous populations of India, and sufficiently rigid to secure Aryan Hindu ascendancy.

In conclusion, I will merely point out briefly how the same process of adaptation, assimilation and absorption, which had been going on for centuries before the Mohammedan conquest, without ever being permanently or even very deeply affected by the vicissitudes of Indian political history, has gone on ever since in spite of seven centuries of alien domination. Whilst millions of Hindus were, it is true, being forcibly converted to Islam, Hinduism, making good its losses to a great extent by the complete elimination of Buddhism, and by permeating the Dravidian races of Southern India, continued its own social and religious evolution. It was, indeed, after the tide of Mohammedan conquest had set in that the rivalry between the cults of Shiva and of Vishnu became most acute, and many of the Dharmashastras and Puranas were recast and elaborated by Shivaite and Vishnuite writers respectively, in the form in which we now know them, and thus afford interesting pictures of the persistency of Hindu life and manners after India had lost all political independence. It was then, too, that Krishna rose to be perhaps the most popular of Hindu gods, and the divine love of which he was at first the personification, was to a great extent lost sight of in favour of his human amours, and that the works known as the Tantras, deriving in their origin from the ancient ideas of sexual dualism immanent in some of the Vedic deities, developed the customary homage paid to the consorts of the great gods into the Sakti worship of the female principle, often with ritual

observances either obscene or sanguinary, or both. Possibly as a result of closer contact with primitive Dravidian religions, the blood even of human victims flowed more freely before the altars of the Mahamatri, the great goddesses personified in Kati and Durga. Sati, *i.e.*, the sacrifice of Hindu widows on the funeral pyres of their husbands, was more frequently practised. Many of the most splendid and, at the present day, most famous temples—amongst others, that of Jaganath at Puri—were founded during that period, when also the practice, in itself very ancient, of religious pilgrimages to celebrated shrines, and to the banks and sources of specially sacred rivers, was laid down in elaborate manuals which became text-books of ritual as well as of religious geography. Much of what might be regarded as the degeneration of Hinduism from its earlier and more spiritual forms into gross idolatry and licentiousness, may well have been in itself a reaction against the stern monotheism of the politically triumphant Mohammedans. Caste, which was as alien to Islam as to Christianity, but nevertheless asserted its influence upon Indian Mohammedans, as it has also upon the later Indian converts to the Christian creeds, tended to harden, and developed into the infinite complexity of castes and subcastes, thousands in number, which are determined sometimes by their occupation, sometimes by ethnological distinctions, sometimes by historical considerations, but which irrevocably govern by the mere accident of birth the whole course of a Hindu's social and domestic relations, and how throughout life he shall eat, drink, dress, marry, and be given in marriage, and ultimately be helped to rebirth in another life.

The most permanent, or at least the most signal, mark which Mohammedan domination has left upon Hinduism has been to accentuate the inferiority of woman by her close confinement—of which there are few traces in earlier times—within the zenana, possibly in the first instance a precautionary measure for her protection against the lust of the Mohammedan conquerors. Twice an attempt was made to bridge the gulf between Islam and Hinduism. Akbar, the greatest of the Moghul emperors, not content to woo the Hindus politically by giving them high offices and promoting matrimonial alliances between his own house and the princely families of Rajputana, sought to found a new state religion acceptable to both Hindus and Mohammedans, of which he was himself to be the prophet, but even his genius failed to square that circle.

More lasting, but within very narrow limits, was the gospel of fraternity taught a century earlier by Kabir, who may have been born a Mohammedan, and certainly had strong leanings towards Islam. But his few writings that have survived, and the doctrines held by the small number of adherents who still revere him, show him to have been essentially a reformer in search, like Akbar, but from religious conviction and not on grounds of political expediency, for a unitary form of religion in which both Hindus and Mohammedans could combine against idolatry and caste.

Such also in his early teachings was Nanak, the founder of Sikhism, which developed afterwards into a political movement of revolt against Moghul tyranny, and on the ruins of the Moghul Empire built up a formidable military state in the Punjab, which fell with Ranjit Singh before the growing power of the British *raj*. Under British rule Sikhism reverted to its original character as a religious sect, and still numbers some three million adherents in the Punjab. It is still fundamentally opposed to Hinduism, but the forces of Hinduism are closing in upon it, and the gradual abandonment of Sikh customs and observances by many of the younger Sikhs, their frequent reversion to Hindu rites, the revival of caste divisions amongst them, the willingness of certain classes of Brahmans to attend their domestic festivities, all point to the gradual resorption of Sikhism into the capacious fold of Hinduism by the same processes that slowly stifled or transformed Indian Buddhism out of existence.

The effect of the British domination, which grew up irresistibly and almost unconsciously from the ruins of Mohammedan domination, has been very different. The British never attempted to impose their own creed on the peoples of India. Their policy was from the very first one of the most strict neutrality and tolerance in religious matters, and missionary enterprise: whatever sympathy it may have enjoyed at the hands of British rulers, has been rigorously confined within the limits of such permissible suasion as can be exercised through philanthropic and educational channels. There were small communities of native Christians in India long before the British ever landed there, some dating to the period of Portuguese ascendancy and some to far earlier times. Even to-day the total number of native Christians does not exceed four millions, mostly in Southern India and largely recruited from the lowest castes of Hinduism, or from the very primitive races

which have never been absorbed into Hinduism. Western civilisation has, nevertheless, exercised indirectly a far greater influence on the mind and soul of India than Islam ever did. Three-quarters of a century ago many Englishmen believed that Hinduism would speedily collapse, or at least undergo complete transformation, under the moral pressure of Christian civilisation and Western education. For a time that belief seemed to be justified. In Bengal especially there was a wonderful response to the call of the West. The youth of the higher castes, who had monopolised the ancient learning, monopolised the new schools of Western learning. Even Brahmans embraced Christianity, and many of those who did not were inspired by its ideals to recognise the necessity of far-reaching social and religious reforms. The names of Ram Mohan Roy (the founder of the theistic Brahmo-Somaj), Keshub Chunder Sen, Debendranath Tagore, stand out conspicuously amongst the pioneers of a brilliant and promising movement which directed its attacks in the first place against idol worship as well as against polygamy and child marriage, and many other social evils of Hinduism incompatible with modern progress. The Prarthana-Somaj, of which Mr. Justice Ranade was, perhaps, the best known supporter, represented somewhat later a similar school of Hindu thought in Western India. As far back as 1829 Lord Henry Bentinck carried a large body of enlightened opinion with him in proscribing Sati; later on the Government of India found enough support for various legislative enactments raising the age of consent for the consummation of infant marriages. Caste itself had to relax some of its most irksome restraints in order to meet the material exigencies of modern conditions of life, and notably the promiscuous contact inseparable from new facilities of travel. One might have expected that the importation into India of Western political conceptions, sometimes of an apparently very advanced democratic type, would have given a vigorous impulse to these reform movements. But this has not been altogether the case. The great Mutiny of 1857, on the surface a military and largely Mohammedan revolt, was to a great extent engineered and supported by the reactionary forces of Hinduism, which had begun to realise how gravely their ancient beliefs and customs and their own privileged position were menaced by the growing ascendancy, spiritual as well as material and political, of Western civilisation under the British *raj*. The racial bitterness engendered by the excesses of the Mutiny and its repression, combined with the diffusion of Western education and of English as the great unifying vehicle of Indian thought amongst the diversity of Indian peoples speaking fifty different tongues, tended to revive and fortify as never before the vague national aspirations of which the germs contained in the ancient literature of Hinduism had already once before, as we have seen, stimulated the Brahmanical reaction against Buddhism. The frank acceptance of the all-round superiority of Western civilisation made room for new movements that recognised only its material but not its spiritual superiority, and were ready to adopt its political methods, but mainly for the purpose of emancipating India from a tutelage which, it was alleged, had paralysed her soul. The effect, if not the purpose, of these new movements has been to relegate social and religious reforms to the background, or at least to confine them within limits compatible with the ancient structure of Hinduism. The Prarthana-Somaj is almost forgotten in Bombay, and in Bengal the Brahmo-Somaj, with all its far-reaching influence, has shrunk into such numerical insignificance that barely five thousand still professed their adherence to it at the last census in 1911.

Of the new movements, the Arya-Somaj in the Punjab professes to have found the secret of the spiritual as well as political renascence of India in a return to the purer Vedic doctrines of early Hinduism. Others appeal to the short-lived and largely mythical glories of a past when, under Hindu rulers, India is supposed to have been free and wealthy and wise beyond all nations of the world.

I have no wish to dwell upon the political controversies of the day, but I may be allowed to draw attention to the very significant part which the theology and religious ritual of Hinduism has played in all the recent phases of Indian political agitation. Most of the secret societies which have borrowed their anarchist methods from the West have placed themselves under the special patronage of Kali and other gloomy divinities of the Hindu pantheon. Mr. Tilak, who first entered public life as a bitter opponent, on grounds of Brahmanical orthodoxy, of the 1891 Bill in restraint of infant marriages, owes his wonderful influence on Mahratta audiences to the skill with which he interweaves his political diatribes with quotations from the sacred literature of Hinduism and appeals to the most popular of Hindu divinities. Nor would Mrs. Besant's

gift of eloquence have sufficed to make Hindus almost forget for a time that she was a mere woman, had she not used it to preach the superiority of Hindu philosophy and Hindu learning and Hindu life over anything that the West has ever produced. Mr. Gandhi's dangerous doctrine of passive resistance would never have borne such tragic fruits, had he not possessed the reputation of a Hindu saint. The Hindu prohibition of cow-killing, which is the most frequent source of violent and often sanguinary rioting between the Hindu and Mohammedan masses, is still a formidable obstacle to the effective co-operation of Hindus and Mohammedans in spite of all the efforts made by political leaders on both sides to reconcile their religious differences. In all essentials, and above all in the iron laws which govern intermarriage, the supremacy of caste still remains practically untouched; and as many societies spring up to defend as to attack ancient customs and superstitions which half a century ago few educated Hindus would have cared publicly to uphold. To quote a Hindu writer:—

"The present political agitation, in its initial stages, had a strong leaven of the spirit of Western politics, but at present a clearer consciousness of Aryan, *i.e.*, Hindu greatness, and a strong love and reverence for the Motherland have transformed it into a shape in which the religious element predominates. Politics is a part of religion and it has to be cultivated in an Aryan way, in accordance with the precepts of Aryan religion."

It is this extraordinary blend of extremely Western forms of political activity with the most ancient religious and social conceptions of the East that invests with peculiar interest the operation of the latest ferment which we are about to introduce into the life of India, in response to Indian demands urged by none more loudly than by the protagonists of Hinduism, by setting up representative institutions of the approved democratic type. How that ferment will ultimately work I for one am not prepared to prophesy, but it cannot be without significance that the first effect has been to provoke an immediate revolt against Brahmanical ascendancy amongst the non-Brahman castes of Southern India—*i.e.*, of the very part of India in which, as it was never entirely submerged by the flood of Mohammedan conquest, the caste system has been most fully preserved. The event alone can show whether it represents a new grouping of real and vital forces within Hinduism which will help to shape the social as well as political evolution of India on Western lines, or whether it will in turn succumb to the same process of resorption which has hitherto prevailed over every movement of revolt against the fundamental principles of Hinduism.

To those who hoped for a more rapid fusion of Indian and Western ideals, some of the phenomena which have marked the latter-day revival of Hinduism have brought grave disappointment, but the inrush of Western influences had, perhaps, been too violent not to provoke a strong reaction. It is easy for us to pass judgment on such institutions as caste and Brahmanical ascendancy, and in a paper read only a few years ago before this society by Sir Krishna Govinda Gupta we heard very severe condemnation passed upon them by one of the most distinguished pioneers of enlightened Indian Nationalism. But let us not forget that to those institutions India owes the one great element of stability that has enabled her to weather so many tremendous storms without altogether losing the sense of a great underlying unity stronger and more enduring than all the manifold lines of cleavage which have tended from times immemorial to divide her. Hinduism has not only responded for some forty centuries to the social and religious aspirations of a large and highly endowed portion of the human race, almost wholly shut off until modern times from any intimate contact with our own Western world, but it has been the one great force that has preserved the continuity of Indian life. Could it be expected to yield without a struggle to the new forces, however superior we may consider them and however overwhelming they may ultimately prove, which British rule has imported into India during a period of transition more momentous than any other through which she has ever passed, but still very brief when compared with all those other periods of Indian history which have only recently been rescued from the legendary obscurity of still earlier ages?

THE CHAIRMAN (Lord Meston), said that, as Sir Valentine Chirol had pointed out at the beginning of his lecture, the present was indeed a very remarkable occasion, because it was the first time on which the Society met to commemorate, in a manner especially appropriate to its great traditions, the memory of one who might, without irreverence, be called the tutelar deity of that institution. Most of those present must have known Sir George Birdwood, and to know him was to love him. Personally he knew Sir George

only in his picturesque old age, and he always appeared to him, not as a normal product of the dull Victorian era, but as the reincarnation of some ancient teacher or mediæval wise man, a sort of Galen or Browne come back to earth again. His ripe wisdom, his inexhaustible fund of knowledge, his whimsical humour, and, above all, his irrepressible vitality, made him a unique figure in the intellectual life of his own generation. But even what seemed in him to be the gift of perennial youth was unavailing against the sharp tooth of fate, and so it was that the audience was present that afternoon to commemorate his memory. He was sure everybody would agree that as a high priest for that ceremony no better choice could have been made than that of Sir Valentine Chirol. His mature sagacity, his wide knowledge of men and affairs, and his happy faculty of felicitous diction, of which they had had so striking a proof that afternoon, marked out Sir Valentine as belonging to that family of chosen spirits of which Sir George Birdwood was a member, and they could almost imagine the quip of happy contentment with which Sir George, from the Elysian fields, would send his greetings to the lecturer, and his congratulations on the treatment of a subject which lay so near his heart. After an intellectual treat, such as the audience had had that afternoon, he was sure they would resent the diminution of its effects by any lengthy commentary. In the circumstances, perhaps, the way in which he could best serve those present was by expressing their gratitude to Sir Valentine for what he had taught them that afternoon. He ventured to say that even the most learned present—and there were many learned men and women in that stately chamber—had learned something from what they had heard in the lecture. What struck him most about it, and what he thought it had probably taught the majority of the audience, was the secret of the enduring power of Hinduism. It had always been a puzzle to many of them how Hinduism had endured the fiery tests and trials to which it had been subjected through thousands of years; how it had succeeded in absorbing the great reforming faiths of Buddhism and Jainism, and how it held its own against the fierce proselytising power of Islam. It was possible that the gentle faith of Buddhism was born into the world too soon; it was seven centuries later before our own great Reformer came upon earth. It was also possible that Islam descended upon India too late, for all that it succeeded in doing in reality was to temper, toughen, and consolidate that wonderful complex of social, intellectual, and religious life which constituted Hinduism. That explanation by itself would, however, be misleading and insufficient, because it was impossible to conceive of a religion which had stood the test of those thousands of years, and which still commanded the hearts of hundreds of millions of people unless it had deep and enduring virtues of its own. He thought the audience had gathered from the lecture what some of its more prominent virtues were—its marvellous organisation of family life, its sagacious outlook upon the future of the human race, and its constant stretching-out for contact with the unknown and invisible world. To many minds there had also arisen the problem on which Sir Valentine touched at the end of his lecture, a problem all the more fascinating because none of those present would live to see its solution, namely, the problem of how Hinduism was going to deal with the new powers which now faced it—powers infinitely greater than the reforming vitality of Buddhism, infinitely greater than the martial ruthlessness of Islam—to wit, the growing force of modern democracy. To most Englishmen, it was, he thought, true that there seemed much in the democratic theory which was radically incompatible with the organisation of Hinduism, and it would be one of the most momentous and most attractive processes of the human mind in the future to see the keen, plastic, Brahmin intellect gird itself up to meet and to conquer, or to absorb, the new forces that were now impinging upon it at every point.

THE RT. HON. LORD GEORGE HAMILTON, G.C.S.I., D.C.L., LL.D., proposed: "That the best thanks of this meeting be accorded to Sir Valentine Chirol for his able and interesting lecture." They had, he said, listened with great pleasure to a singularly erudite and comprehensive address, expressed with all the literary finish characterising Sir Valentine Chirol's writings. It was worthy of the occasion and of the distinguished man to whose memory it was dedicated. He took it as a great personal privilege that he had been asked to speak upon it. The matter of the lecture was so voluminous, its retrospect and deductions so far-reaching, that he felt himself quite unable to attempt to analyse or criticise its general purport. But he greatly admired and appreciated the detachment of its tone, its liberality of sentiment, and its tolerance of Asiatic philosophy and doctrines which were, at first sight, antagonistic to accepted European traditions and aims. He desired to concentrate the few words he had to say upon the career, character, and achievements of that notable man, the late Sir George Birdwood. He knew Sir George very well. He (Lord George Hamilton) spent the greater part of his official life at the India Office; he was for five years Under-Secretary of State, and for eight years Secretary of State, and during the whole of that period he was in close personal contact with Sir George, and when out of office his correspondence with him was varied and continuous. Few, if any, Anglo-Indians equalled him in his knowledge of Indian art, industries, and literature, and this encyclopedic mass of information was always at the disposal of his friends. He had also studied very carefully the psychology, past history, and present ambitions of the great races of India, though, from his residence in the West of India, it was to that part of the country that he gave most of his attention. He (Lord George Hamilton) once asked a most

distinguished Anglo-Indian administrator what was the feeling most embedded in his mind about India when, after a lifetime of hard work, he came home to England, and his reply was: "How little I knew of the country and of the inner thoughts of its people." Long as was his official connection with India, though his experience was purely English, he always came back to that opinion. It was not the fault of the Indian or of the Englishman; it arose from the fact that there was a natural chasm between the mentality of the Asiatic and the mentality of the European which few could effectually bridge over. Sir George was one of the few so gifted and so possessed, and he always utilised his knowledge and gifts to help others to achieve the same feat. In speaking of the difference between Asiatic and European minds, it must not for a moment be supposed that he meant that where the difference existed the European was always right and the Asiatic wrong. Behind India there were customs, traditions, and religions immeasurably older than our own. They were to a large extent stabilised and immutable, and the outcome of those influences was always asserting itself, even though the words used might not seem to fit into our polity and acquiesce in our objects. A well-known Anglo-Indian editor once said that Europe could not found a religion, or Asia make a steam-engine. All intellectual religions had Asiatics for their founders; mechanics and the harnessing of the latent forces of nature to purposes of utility were European attributes. So it came to pass that, with the best of intentions, the two mentalities, each excellent, but with limitations, constantly found it difficult to secure that unity of conception and co-operation which a single-minded race could achieve. That was especially the case when reforms and changes based on European ideas were to be transplanted and sown on Indian soil. The words used on both sides might not be the same. The mouth might give utterance to the same phraseology, but the interpretation of what those words conveyed or to what they might lead was at times irreconcilably different. The lecture was entitled "The Enduring Power of Hinduism," and the author gave undeniable and historical evidence of its strength and vitality. The backbone of Hinduism was Brahminism, and caste was the vertebræ of that backbone. There was a struggle for a few centuries between the conflicting tenets of Buddhism and Brahminism. The first religion gained the upper hand, but Brahminism then, as the lecture showed, so asserted itself as to eradicate completely its rival from Indian soil. He did not wish to introduce any contentious element into his speech, but when he heard that a representative government on a popular basis was to be adopted in India, he asked himself, "How can any such form of government exist alongside of the institution of caste?" Again, European ideas of administration were all based upon the supremacy of the majority; but from time immemorial India had been governed by racial minorities, small in numbers compared to those they controlled. Taking the Hindu family system, the devolution and retention of property was governed by the continuous observance of religious duties performed by the living for the edification and honour of the dead. There, again, there was a chasm of divergence between the practices of Hinduism and Christianity. He had a remarkable illustration of that whilst in office. He received a memorial signed by the heads of every Christian community in India protesting against the oppression of Christianised Hindus in the South of India. It was alleged that, in consequence of becoming Christians, they were punished by being deprived of that part of the family property which they would have enjoyed if they had remained Hindus. It was pointed out that in the Royal Proclamation which was issued when India was transferred to the Crown it was laid down that no person was, directly or indirectly, to be penalised on account of his religious tenets, and that what was going on in South India was a flagrant infraction of that principle. The facts alleged were undeniable. The Hindu version was that family life and family property, whether partible or impartible, were governed by the constant performance of religious ceremonies in honour of the dead. If an individual changed his religion, he *ipso facto* was unable to perform these duties, and dropped out of the family life and the laws of inheritance. To do what was asked was to give an apostate Hindu a pecuniary advantage over his orthodox family contrary to Hindu custom. It was putting a premium upon religious apostacy. They accepted the Hindu contention, as it was in accordance with Hindu law, tradition, and the justice of common-sense. He could multiply other instances of the necessity of trying to look at Indian questions from an Asiatic point of view, and of cultivating the attitude in such matters which Sir George Birdwood so consistently maintained. He asked no one to subordinate his sense of right to wrong or to cultivate popularity by the advocacy of impracticable and dangerous experiments. But he implored them to approach all Indian problems, as did Sir George, not in a mood of bias or inherent superiority, but in a spirit of vigilant investigation and receptivity.

SIR HENRY TRUEMAN WOOD, in seconding the motion, said Sir George Birdwood had a very large number of friends, all of whom loved him, but he was not prepared to say they always agreed with the conclusions to which a somewhat impetuous spirit and a rather fantastic imagination sometimes carried him. He did not think, however, anyone could have been associated with Sir George Birdwood without acquiring a sincere affection for him. His friends appreciated his genuine artistic capacity; they recognised the vast extent of his literary and artistic knowledge, to say nothing of his scientific knowledge; and, above all, they admired and appreciated the manner in which he devoted himself to the task of his life—the benefit of the peoples of India, and the dissemination in

this country of a better knowledge of that country in which he himself was born. They could not have wished for any better initiation of the memorial which they had established in the hope of preserving some record of Birdwood and his life than the very brilliant essay which had just been delivered; and he thought if it were possible for their friend to have heard it, he also would have estimated at a very high value the contribution which Sir Valentine Chirol had made to the work which he had nearest his heart.

Sir Henry concluded by expressing the thanks of the Council to Lord Meston for presiding and assisting the Society in the establishment of the Birdwood Memorial.

The motion was carried unanimously, and Sir Valentine Chirol having briefly acknowledged the compliment, the meeting terminated.

SHEEP FARMING IN PATAGONIA AND TIERRA DEL FUEGO.

The profit in sheep farming on a large scale in Patagonia and Tierra del Fuego during the last three years is shown by the annual statements of La Sociedad Explotadora de Tierra del Fuego, of Valparaiso and Punta Arenas, one of the largest, if not the largest, sheep-farming companies in the world. The concern has a capital of £1,800,000, and controls, under deeds and Government leases, 945,770 hectares (2,337,038 acres) of land, the greater part of it on the island of Tierra del Fuego. To inclose its farms the company has built to date 8,297 kilometres (5,155 miles) of wire fence.

The statements cover the period from July 1, 1916, to June 30, 1919, and show a total profit in the three years of £2,721,947, or £921,948 in excess of the capital. Dividends totalling £1,980,000, or 110 per cent. were paid. The company marketed a total of 26,929,127 pounds of wool, and sold for meat 991,747 animals. The average price per pound received for wool in the fiscal year 1916-17 was 20·07*d.* (40·69 cents); in 1917-18, 29·22*d.* (59·24 cents), and in 1918-19, 23·58*d.* (47·80 cents). The price per head received for the sheep sold for meat was 17*s.* 7*d.* (4·27 dols.) in 1916-17; 17*s.* ½*d.* (4·14 dols.) in 1917-18, and 20*s.* 10½*d.* (5·07 dols.) in 1918-19.

The number of sheep sheared by the company in 1916-17 was 1,173,219; in 1917-18, 1,184,224; and in 1918-19, 1,139,505.

La Sociedad Explotadora de Tierra del Fuego is a Chilean company, but the general manager and all farm managers are British.

ARGENTINE CARPET WOOLS.

The so-called carpet wools of Argentina are known in that country as *criollo* (creole or native) wools. For some reason or other they have been known in the United States as Cordova (Cordoba) wools, and were formerly so denominated in the older United States tariffs. As a matter of fact, however, these creole or carpet wools are produced not only in the Province of Cordoba, but in those of Mendoza, Santiago del Estero, San Luis, and in a part of the Territory of La Pampa. There are various odd sorts produced in other provinces, but these amount to nothing of importance in connection with carpet wools.

Taking into consideration the length of staple and the shrinkage, the best native wools are those from Cordoba, Mendoza, and San Luis, although it is believed, in the absence of actual official statistics, that the Province of Santiago del Estero produces more of these wools than any other province; and, while it is generally short in staple on account of its frequent shearing, it nevertheless sells for about the same prices as other wools in a normal market. On the average, creole wool will yield from 47 to 55 per cent. when clean scoured.

At the end of 1915 the three leading provinces of Argentina in the numbers of sheep were:—Buenos Aires, with 18,535,935; Entre Rios, with 4,413,545; and Corrientes, with 2,410,279. According to the third national census of 1914, these three provinces had, respectively, only 425,660, 488,655, and 509,956 criollo or native sheep; while the same census showed a preponderance of these native sheep in other provinces, as follows:—

Provinces and classes of sheep.		Number of sheep.
Cordoba	Pure	32,242
	Mixed	713,408
	Native	664,836
Mendoza	Pure	973
	Mixed	46,099
	Native	251,415
Santiago del Estero	Pure	195
	Mixed	18,656
	Native	723,058
San Luis	Pure	27,885
	Mixed	231,847
	Native	332,378

The above figures give some idea of the proportion of native wool produced in the respective provinces.

The sheep are pastured principally in the valleys or at the foot of the hills in the above-named provinces, and the flocks are small compared with those in the more important sheep provinces. The crudest conditions exist, and probably the only reason that the sheep are, as a rule, driven into a corral of thorns at night is the fear of wild animals. The sheep must be exceedingly hardy, since the climate is hot and the pasturage scanty in summer, and the cold severe in winter. On account of the sudden climatic changes that take place, the mortality is greater from cold than from diseases, especially after shearing time. In the provinces of the north of the Republic, the only sheep are the

creole, as the pasturage would not suit other classes. With the exception of the highest priced pure-bred breeding sheep, all sheep in Argentina, even in the coldest regions of the extreme south, are pastured in the open, and are not given any feed in addition to the pasturage during any part of the year.

The methods of tending the flocks and shearing the sheep are primitive. The average clip per sheep is about 5½ lb., the fleeces of those raised toward the plains or at the foot of the hills being the lighter, while the fleeces of the districts of high altitude contain more grease and weigh probably from 7·7 to 8·8 lb. In all creole wool there is a trace of merino, so far as fineness is concerned; for, while the points and possibly half of the staple may be coarse, at the roots and even in some of the fleeces there is a fineness which could only have originally come from the merino or Rambouillet. In other words, there are no longer any strictly native or creole sheep any more in Argentina, the mixture having come about through primitiveness or carelessness in the tending of the herds.

It appears from a report by the United States Consul-General at Buenos Aires, that during the past fifteen or twenty years the production of carpet wool in Argentina has been decreasing, and the export has fallen off considerably because of the increasing use of the wools in the domestic market. The making of wool mattresses in Argentina has greatly increased. These mattresses are commonly used in South American countries, about 90 per cent. being made of creole wool, which is superior for this purpose to any other class of wool because it retains an elasticity which can be constantly renewed by opening out the mattresses.

The individual producer of creole wool runs an account with the nearest important store, and he exchanges his sheep or his wool for stores or sells for cash. The stores in turn sell to the travellers of the export houses in Buenos Aires, Rosario, and other cities, or they send the wool to the Argentine markets against an advance from the firms or brokers in those markets. There is not much fear of control by special interests, because hides, skins, hairs and other animal products are, as yet, bought more or less through the same dealers.

A notable feature in the creole wool business is the heavy taxation, since, apart from the national export tax, wool and other products are subjected to a provincial tax when they are exported from a province. The rates vary in each province. Wool coming from the provinces of Entre Rios, Corrientes, and Buenos Aires, and from the Territory of Santa Cruz, in which are included the best wools that the country produces, pay smaller export taxes than the creole and other inferior wools. Since, therefore, the raiser of these carpet wools receives less consideration, as compared with the growers of wool living in the more fortunate provinces, it is easy to arrive at the reason for the constant decrease and the semi-abandoned trade in these cheap wools.

MUSK TRADE OF CHINA.

In normal years the exportation of musk from China averages in value upwards of £75,000. The Great War and disturbed conditions in China have interfered with this trade. The musk is collected principally on the Tibetan-Chinese frontier, the city of Tachienlu being credited with handling the commodity to the value of 300,000 taels annually.

The following particulars, received in Shanghai from Tachienlu, have been made the subject of a report by the United States Consul-General at Shanghai:—

The chief point for the collection of musk on the Tibetan-Chinese border, the city of Tachienlu, draws its supply from a wide area, the musk being brought in by hunters and traders, and by Chinese merchants or their representatives in the interior. This article, which is obtained from the male musk deer (being the secretion of a certain gland), is received in its original form in what is known as a pod—a small, contracted skin pouch, seldom larger than a walnut. A pod sometimes contains as much as 2 oz. of musk, but usually the amount is less than an ounce. From Tachienlu, and other interior towns where it is collected, the musk is shipped in the pod form to the coast during the cooler months of the year, as, owing to the heat and moisture, it is likely to mould and spoil if shipped during the hot season.

The high value of musk offers a strong inducement for its extensive adulteration. In consequence of such adulteration, which is often most difficult to detect, it is considered a good average if, in a year's purchases, as much as 80 per cent. of pure musk is obtained. Among the adulterants used may be mentioned peas, barley, grains of wheat, mashed acorns, fried liver, and pulverised beef. It may be of interest to note the average prices for musk which have prevailed in Tachienlu in recent years:—1914, 15 taels per ounce, gross weight; 1915, 13 taels; 1916, 11 taels; 1917, 11 to 12 taels; 1918, 11 to 12 taels; and 1919, 12 to 24 taels. (The value of the haikwan tael has risen from 2*s*. 8½*d*. in 1914 to 5*s*. at the end of 1919.)

The number of deer killed annually to supply the musk market is enormous. In a general way it may be said that twenty-two pods of musk are required to make 1 catty (1·33 lb.). It will be seen, therefore, that the production of 1 catty of musk represents the destruction of at least twenty-two deer. Moreover, in taking the animals, the females and the young

are slaughtered indiscriminately, notwithstanding the fact that the musk pod is obtained only from the full-grown male deer. It may be said, in passing, that the venison is esteemed a great delicacy among the Chinese, while the hide, which is remarkable for its softness, is of considerable commercial value. It is estimated that more than 100,000 deer are slaughtered annually in supplying the musk market of the towns on the Szechuan-Tibetan border. From this it would seem that should there be an increase in the demand for musk the animals might be exterminated. In view of this contingency, there has been suggested the feasibility of rearing the deer in captivity with a view to drawing off small quantities of the musk annually.

OIL-YIELDING PRODUCTS AND SEED-CRUSHING INDUSTRY OF EGYPT.

Among the oleaginous products of Egypt and the Anglo-Egyptian Sudan, cotton seed is the only one of interest to the world's markets. The exportation of groundnuts and sesame is limited to adjacent territory, and is not important. Almost the entire production of oleaginous material is the result of cultivation, but statistics of production are not available. About 50 per cent. of the groundnuts, all of which emanate from the Sudan, are consumed as human food.

As a general practice, writes the United States Consul at Alexandria, the Egyptian cultivators divide their land into three parts: One part is planted in cotton; one in dura (native grain); and one in berseem (fodder). About 75 per cent. of the cultivated land is held by individuals owning less than 2 acres. On these small patches no machinery is used, and only the most antiquated implements are employed. In Lower Egypt water is raised from irrigation ditches, for the most part, by hand-manipulated spiral lifters. In Upper Egypt this water lifting is done generally by an apparatus consisting of a bucket attached to a pole with a balance weight.

The only crushing of commercial importance in Egypt is limited to cotton seed. The cotton seed crushing industry in Egypt was established, and is maintained solely for the purpose of supplying the local demand for cottonseed oil. Only a very small proportion of the oil produced is exported; in normal times none of the cake is consumed locally. The entire supply of seed crushed by Egyptian mills is of local origin.

Egyptian mills are equipped with modern machinery, having been reconstructed periodically. The quality of the oil is good. Most of the mills are operated on scientific principles and employ chemists. The total approximate production of oil and cake in Egypt during 1913 was 11,150 metric tons of oil, and 63,000 tons of cake. Owing to the allotment system inaugurated by the Cotton Seed Control Board, the production during 1918 very much decreased. Statistics of oil production, as such, are not available, but may be approximated from the quantity of oil cake exported (all the cake produced in normal times is exported), at the ratio of $5\frac{2}{3}$ to 1. During the war no cake was exported. A large quantity was consumed locally as fuel. A ton of 2,000 lb. of Egyptian cotton seed will yield approximately 330 lb. of oil and 1,600 lb. of cake.

NOTES ON BOOKS.

A Manual of the Timbers of the World, their Characteristics and Uses. By Alexander L. Howard. London: Macmillan & Co. 30*s*. net.

The object of this work, as stated in the preface, is "to meet a distinct want for a clearly-arranged handbook which shall contain information concerning all the timbers encountered in commerce, including those which have only of recent years appeared in the European market. The aim has been to treat the subject from its commercial, technical, and industrial aspects."

The main portion of the book consists of a catalogue of timbers, beginning with *Abey*, a wood much resembling mahogany, that comes from San Domingo, and ending with *Zizyphus Jujuba*, a wood not unlike the black walnut, which grows in India. Between these extremes are descriptive notes of some 450 timbers, illustrated in many instances with excellent photographs. The notes give careful descriptions of the woods, their colours and markings, and indicate the various uses to which they are specially adapted. To carry out this work as effectively as it is here done requires an immense amount of experience. Mr. Howard has been connected with the timber industry for over forty years, and in most instances he speaks from personal knowledge of the merits and characteristic qualities of the materials described; in other cases he quotes from high authorities whose names he gives.

It will be seen at once that a work of this kind will prove of the utmost value to all whose business it is to study the uses of different timbers. As the book is arranged alphabetically reference is rendered very easy. If one might make a trifling suggestion it would be that in future editions the names of the trees should be printed at the top of the pages on which they are described, as is usually done in the case of dictionaries.

In addition to the actual facts set forth in the catalogue, Mr. Howard discusses incidentally many points of great interest. He mentions, for instance, the tendency to demand Austrian oak in British specifications, and we are glad to find in him a stalwart champion of the English tree. A useful section is devoted to the artificial seasoning of timber, where he states the interesting fact that he had had experience of some very large timber

dryers in Finland used to fulfil certain conditions, one of which was "to turn out the dry timber without discoloration, so that it could be sold in England and elsewhere as 'Guaranteed NOT Kiln-dried.'"

We note with pleasure that particulars are given of the properties of several Indian timbers, such as Alexandrian Laurel (*Calophyllum Inophyllum*), which hitherto have been little known in this country. Any one who visited the Empire Timber Exhibition, recently held at Holland Park Skating Rink under the auspices of the Department of Overseas Trade, must have been greatly struck by the exhibits of these woods which were prepared by Mr. Howard for the Government of India. Attention was drawn to these in the *Journal* of July 16th (p. 567), and we can only repeat the hope there expressed that these timbers will become more and more widely known among our furniture makers.

GENERAL NOTES.

JAPANESE LABOUR.—A report on industrial conditions in Japan, by H.M. Vice-Consul at Osaka, describes (Cmd. 511) the social problems associated with the establishment and expansion of industries. Up to the present it is stated that the Government in Japan has made little effort to deal with the situation. A Factory Act was passed in 1916, but its most important provision—the prohibition of night work for women and young persons—is not to come into operation until 1933. Working hours were fixed at twelve, but exemptions are granted to factories where only males over fifteen years of age are employed, and to silk factories until 1931. The prohibition of the strike has hindered the organisation of labour and retarded the development of trade unionism. Conditions in the towns appear to be very bad, with the inevitable result that epidemics are very frequent. Rents are high owing to the scarcity of houses, and this is leading to the rapid growth of slums, in which some of the houses have no flooring but the bare earth, and no ventilation. Wages are low despite the increases which have been given during the war, labour being very plentiful and inefficient. It is usual for all members of a family who are old enough to work from early morning to late at night—many Japanese industries still being carried on in the home. The hours worked in the factory are usually eleven or twelve a day, with three or four days' holiday in the month, the machinery running night and day. The average wages of the males employed by forty three cotton spinning companies have risen from 1*s*. a day in 1914 to 1*s*. 8*d*. in 1919; the wages of women have risen from 7¾d. in 1914 to 1s. 2¼d. in 1919. Three-quarters of the labour employed by spinning and weaving companies consists of women and children. Girls from the age of sixteen to twenty-two come into the mills from the country districts and work ten or twelve hours a day and go on night work every alternate week. They are housed on the premises and fed by their employers for a nominal charge; their wages vary from 6*d*. to 1*s*. 8*d*. a day. At present the average working period for a girl is about one year. Many large firms are now taking a great interest in their employees and are providing medical attendance, playgrounds, and shops where cheap luxuries can be bought.

THE AUSTRALIAN BLACKBOY TREE.—A peculiar product of the vegetable world is what is known as the "blackboy" tree, which flourishes in the State of Western Australia. It is, in fact, a species of the grass tree, and grows to a normal height of 7 to 10 feet, and is found to be useful for a variety of purposes. Until recently no attempt has been made to utilise the tree commercially, but, according to a report published in the *Weekly Bulletin* of the Canadian Department of Trade and Commerce, a company has now been formed to work and market its by-products. The plant consists of nineteen sets of retorts and furnaces, condensers, receiving tanks, etc., and can deal with 100 tons of gum and other material derived from the tree. The company at present employs about twenty men, besides cutters, and among other things being produced are tars (free from harmful acids), tarpaulin dressings, rope tar and sanitary tar, lacquers (such as Japan black), steam and refrigerating pipe lagging, paint for ironwork that requires stoving at high temperature, stains and paints, pitches for marine insulating, phenol, benzol, and alcohols, coke, potash and pyrogeneous acid. The production of dyes, perfumes, and formalin, and various kinds of varnishes is also planned. The formation of this company is the outcome of experiments made by the late Mr. Henry Lowley, the city analyst of Perth, who devised the methods of extracting and treating the gum, pith, and fibre of the tree.

PHOSPHATE DEPOSITS IN THE NETHERLANDS.—According to a report by the United States Commercial Attaché at The Hague, phosphate deposits have been discovered in the eastern part of Holland, at a place called Ootmarsum, in the Twente District. About 30 tons of 15 to 20 per cent. phosphate are being produced each day, and are being sold locally at prices corresponding to the prices of imported phosphate. The stratum varies from 7 inches to 3 feet in thickness, but on account of the fact that it is not continuous the work of extracting the rock is very expensive. In some places the stratum is on the surface; in others it is as much as 25 feet beneath the surface.

TOBACCO PIPES FROM AUSTRALIAN WOODS.—Tobacco pipes are now being made from Australian woods, which in appearance and finish compare very favourably with imported pipes of good quality. In one of these factories in Melbourne all of the work is done by disabled Australian soldiers, and employment is reserved for them exclusively.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

SYNTHETIC DRUGS.

By JOHN THEODORE HEWITT, M.A., D.Sc., Ph.D., F.R.S.,

Emeritus Professor of Chemistry, East London College.

Lecture I.—Delivered December 1st, 1919.

In attempting to give an adequate account of the synthetic drugs in a course of three lectures it is necessary that somewhat circumscribed limits should be set regarding the matters considered. The term synthetic drug implies that a substance is artificially produced and that it finds a use in medicine, so that numerous fairly simple compounds could be logically included. Common usage has, however, restricted the term to more or less complex carbon compounds which are either prepared by truly synthetic methods (*e.g.* veronal) or by modifying the structure of naturally occurring compounds by oxidation, reduction, acylation, alkylation, etc.

Accepting this generally implied meaning we should include on the one hand simply-constituted compounds like chloroform and ethylchloride, and on the other complicated compounds such as diacetylmorphine. The preparation of the simpler compounds can be assumed to be known to those present, in fact it would be impossible to afford time for treating them in anything but a cursory manner.

Time also prevents more than passing remarks being made about the various colloidal metallic preparations, in fact these can scarcely be described as "synthetic" in a strict sense.

CLASSIFICATION.

The subject-matter to be dealt with may be classified either on the lines of systematic organic chemistry, dealing with the members of one class of compounds at a time, or arranged according to the effect produced, considering disinfectants in one group, hypnotics in another, and so on; this is the course which has been most generally followed. In adopting a classification based on chemical considerations the saving of time thereby accruing has had considerable influence, and the survey of the subject may be rendered more systematic, whilst the lecturer being a chemist himself feels on safer ground.

Since chloroform was one of the first artificial compounds to be used in medicine or surgery we may well begin with the derivatives of the simpler hydrocarbons.

DERIVATIVES OF THE ALIPHATIC HYDROCARBONS.

Small amounts of the paraffins and olefines have no very pronounced action on the organism, but their halogen substitution derivatives have in many cases well-marked anæsthetic properties.

Methyl Chloride—CH_3Cl, b.p. $-24°$—is obtained either from methyl alcohol and hydrochloric acid in presence of zinc chloride (Groves, *Annalen*, 1874, 174. 378), or by heating trimethylamine hydrochloride obtained from beet molasses (Vincent, *Jahresb.* 1878. 1135). It is used as a spray to produce local anæsthesia, and in lumbago, neuralgia and sciatica; its action on the skin, however, is against it.

Methylene Chloride—CH_2Cl_2, b.p. 41·6°—is obtained from methylene diodide and chlorine, by the reduction of chloroform and by the action of phosphorous pentachloride on polyoxymethylene.

Chloroform—$CHCl_3$, b.p. 61°—was first introduced as an anæsthetic by Simpson in 1848. It is obtained by the action of bleaching powder on alcohol or acetone, or by the decomposition of chloral by alkalies. It is also formed by partial reduction of carbon tetrachloride.

Carbon Tetrachloride—CCl_4, b.p. 77°—can be obtained by the action of chlorine on carbon disulphide in the presence of antimony. Its action on the human organism is harmful.

Ethyl Chloride—C_2H_5Cl, b.p. 12·5°—is formed when hydrogen chloride acts on ethyl alcohol in

presence of a metallic (*e.g.* zinc) chloride. It is chiefly used for producing anæsthesia in minor operations, sometimes in conjunction with ether and chloroform.

Ethylene Dichloride—$C_2H_4Cl_2$, b.p. 84°—has found use as an anæsthetic; S. J. Wallace has employed it as a solvent for iodine in disinfecting the skin (*British Medical Journal*, 1910, 1288).

Dichloroethylene (Acetylene dichloride, dioform)—$C_2H_2Cl_2$, b.p. 55°—is said by Villinger to have given good results as an anæsthetic; the number of experiments was rather limited.

Bromoform—$CHBr_3$, m.p. 7·5°, b.p. 151°—is obtained by the action of alkaline hypobromites on alcohol or acetone, or by electrolysis of a solution of potassium or calcium bromide in dilute alcohol (Schering, D.R.P. 29771). It is used in whooping-cough.

Ethyl Bromide—C_2H_5Br, b.p. 38°—is prepared by distilling a mixture of alcohol and sulphuric acid with a bromide. Separation from accompanying ether is difficult owing to the nearness of the boiling points; Riedel suggests agitation with concentrated sulphuric acid (D.R.P. 52982). Ethyl bromide is an anæsthetic.

Iodoform—CHI_3, m.p. 119°—is obtained by the action of iodine and an alkali or alkaline carbonate on alcohol, acetone, etc. The production of iodoform by electrolysing an aqueous alcoholic solution of potassium iodide and sodium carbonate (Schering, D.R.P. 29771) must be looked on as a modification of the former process. Iodoform may also be obtained electrolytically from acetone (Teeple, *Journal of the American Chemical Society*, 1904, 26. 170).

Alcohols.

The aliphatic alcohols employed as such, or as esters in medicine, are usually non-synthetic in origin; a few artificially prepared alcohols, mostly containing halogen, have been introduced.

Trichloroisopropyl Alcohol (Isopral)—$CCl_3 \cdot CHOH \cdot CH_3$, m.p. 49°. This compound was introduced as a hypnotic (Bayer, D.R.P. 151545), being obtained by the action of methylmagnesium bromide on chloral.

Trichloro-tert.-butyl Alcohol (Chlorbutol, Acetone-chloroform, Chloretone)—$(CH_3)_2(CCl_3)COH$, m.p. near 97°, b.p. 170–171°—was obtained by Willgerodt (*Ber.* 1882, 15. 2308, Willgerodt and Gemeiser, *J. pr. Chem.*, 1888, 37. 365), by the action of caustic potash on a mixture of acetone and chloroform. The reaction is never complete; it was thought at first that there were two modifications, but Cameron and Holly (*Journal of Physical Chemistry*, 1898, 2. 522) have shown that the only "acetone-chloroform" is the crystalline substance smelling like camphor and melting, if anything, above 97°. The supposed liquid modification is simply the same substance mixed with acetone and water. They explain the formation of the compound thus:—

$$\begin{matrix}CH_3\\CH_3\end{matrix}\!\!>\!CO + KOH = \begin{matrix}CH_3\\CH_3\end{matrix}\!\!>\!C\!<\!\begin{matrix}OH\\OK\end{matrix}$$

$$\begin{matrix}CH_3\\CH_3\end{matrix}\!\!>\!C\!<\!\begin{matrix}OH\\OK\end{matrix} + CHCl_3 = \begin{matrix}CH_3\\CH_3\end{matrix}\!\!>\!C\!<\!\begin{matrix}OH\\CCl_3\end{matrix} + KOH$$

Besides possessing hypnotic properties, chlorbutol acts as a local anæsthetic, analgesic, and antiseptic.

Brometone—$(CH_3)_2(CBr_3)COH$, m.p. 167°—also possesses hypnotic and analgesic properties. It has been recommended in sea-sickness.

Tertiary Amyl Alcohol (Amylene Hydrate)—$(CH_3)_2(C_2H_5)COH$, b.p. 102·5°—was first obtained in a pure condition by the action of zinc methyl on propionyl chloride (Popoff, *Annalen*, 1868, 145. 292). It is more easily made by Wischnegradsky's method (*Annalen*, 1877, 190. 332). Ordinary commercial amylene such as is obtained by dehydrating fusel oil with zinc chloride (Wurtz, *Bull. Soc. Chem.* 1863, 5. 301) consists chiefly of trimethylethylene. This, when shaken with diluted sulphuric acid, unites with water to form the tertiary alcohol.

Amylene hydrate has been used as a hypnotic, intermediate in its action between chloral hydrate and paraldehyde.

Aldehydes.

Aldehydes are formed by the oxidation of primary alcohols. The two simplest aldehydes, either monomolecular or polymerised, find very extensive application.

Formaldehyde (CH_2O). This compound was obtained by Hofmann in 1867 (*Proceedings of the Royal Society*, 16. 156), both as a gas and as solution in dilute methyl alcohol. Air was saturated with the vapour of methyl alcohol and led over a spiral of platinum wire, a limited and flameless combustion taking place.

Trillat first developed the oxidation process technically (French patent 199919, 1889; D.R.P. 55176), using platinised asbestos or other contact substance. Further modifications were introduced by Klar and Schulze (D.R.P. 106495). Bone and his co-workers (*Transactions of the Chemical Society*, 1903, 83. 1074; 1904, 85. 1637; 1905, 87. 1232) found that formaldehyde

was an intermediate product of the combustion of methane and other hydrocarbons, and Glock (D.R.P. 109014) has suggested the oxidation of methane over granulated copper at 600° as a method of making formaldehyde.

Various other methods of oxidising methyl alcohol have been devised, *e.g.*, by manganese salts in acid solution (Lang, D.R.P. 166357), ammonium persulphate (Ditz, *J. pr. Chem.* 1909, ii. 78. 359), moist chlorine (Brochet, *Compt. rend.*, 1896, 122. 130, 1156), etc. The formation of formaldehyde and hydrogen by leading methyl alcohol vapour over finely divided copper at 200° is of special interest in view of the use that has been made of the corresponding reaction in the case of ethyl alcohol (Sabatier and Senderens, *Compt. rend.* 1903, 136. 922).

Whilst the technical processes of producing formaldehyde depend on the oxidation of methyl alcohol, it is well to remember that the compound has been obtained by reduction of formic acid and even carbon dioxide (Badische, D.R.P. 185932; Fenton, *Transactions of the Chemical Society*, 1907, 91. 687; Bach. *Compt. rend.* 1898, 126. 479; K. Jahn, *Ber.* 1889, 22. 989; Chapman and Holt, *Transactions of the Chemical Society*, 1910, 97. 917; Brodie, *Annalen*, 1874, 174. 284; De Hemptinne, *Bull. Acad. roy. Belgique*, 1897, ii. 34. 269; Losanitsch and Jovitschich, *Ber.* 1897, 30. 136; Löb. *Z. El. Chem.* 1905, 11. 749; 1906, 12. 295).

The formalin or formol of commerce usually contains 40 per cent. of formaldehyde, together with 8 to 20 per cent. of methyl alcohol dissolved in water.

Formaldehyde is easily polymerised by acids.

Paraformaldehyde is at least a three-fold polymer.

Trioxymethylene is obtained by the action of sulphuric acid on formaldehyde solution (Cambier and Brochet, *Compt. rend.* 1894, 119. 607). According to Auerbach and Barschall (*Arb. Kais. Gesundh. Amt*, 1907, 22. 584) four polyoxymethylenes (α, β, γ, δ) can be prepared; the commercial trioxymethylene consists of the γ or $\beta + \gamma$ modifications. A really crystalline α-trioxymethylene may be prepared from the commercial product by heating in a current of nitrogen and fractionating the condensate (m.p. 63–64°, b.p. 114·5°). This substance does not show aldehydic reactions, and is evidently a cyclic compound.

Paraformaldehyde differs chiefly from this compound by amorphous condition and content of absorbed water.

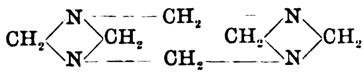
The disinfectant properties of formaldehyde make it valuable in itself. Additionally it is used in the preparation of derivatives which undergo hydrolysis with liberation of formaldehyde.

Hexamethylene-tetramine (Formamine—$C_6H_{12}N_4$) is also used under a variety of names, *e.g.*, Hexamethylenamina (U.S.P.), Hexamine, Aminoform, Urotropine, Cystamin, Formin, Metramin, Urisol, Uritone, Vesalvine, Xametrin.

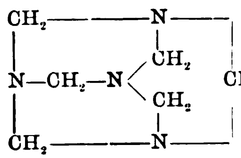
The compound was first obtained by Butlerow (*Annalen*, 1860, 115. 322) by the action of ammonia on polyoxymethylenes. It may also be obtained by the action of ammonia on other methylene compounds. According to Wohl, formaldehyde vapour is led into concentrated aqueous ammonia, the solution evaporated, being kept ammoniacal meanwhile, and the resulting syrup dissolved in hot absolute alcohol (*Ber.* 1886, 19. 1842). Grassi and Motta (*Gazzetta*, 1899, 29. 1, 43) dissolve polyoxymethylene in concentrated aqueous ammonia and then evaporate with occasional addition of ammonia.

One hundred parts of the following solvents at 12° dissolve hexamethylene-tetramine in the respective amounts—water, 81·3; alcohol, 3·22; chloroform, 8 parts. The compound is not appreciably soluble in ether (Delépine, *Bull. Soc. Chim.* 1895, iii. 13. 353).

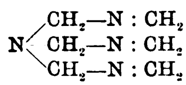
Various constitutional formulæ have been proposed, *e.g.*—



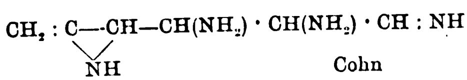
Van 't Hoff



Duden and Scharff



Löschkaun



Cohn

Hexamethylene-tetramine has an alkaline reaction, and is a monocid base, forming such salts as $C_6H_{12}N_4 \cdot HCl$. Moreover, it unites with one molecule of an alkyl halide (Vohle, *Ber.* 1886, 19. 1840; Delépine, *Bull. Soc. Chim.* 1895, iii. 13. 355). Some acid salts have been prepared, *e.g.* $C_6H_{12}N_4(HNO_3)_2$ and three metaborates with 1, 2 and 3 molecules of HBO_2 have been patented (A.-G. Anilinfabrik, D.R.P. 188815).

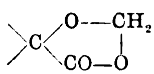
It is enerally supposed that the antiseptic value of hexamethylene-tetramine depends on the liberation of formaldehyde by acid hydrolysis; on the other hand, E. Zak considers it to be itself an efficacious antiseptic.

Numerous salts and addition products have been introduced under trade names; the following list makes no pretence at completeness:—

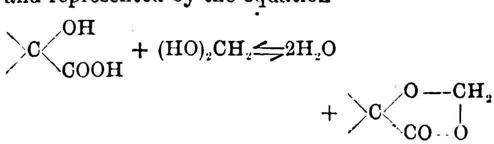
Amphotropin.	Camphorate.
Bromalin.	$C_6H_{12}N_4 \cdot C_2H_5Br$.
Cystopurin.	$C_6H_{12}N_4(NaC_2H_3O_2)_2+6H_2O$.
Formicin.	Acetamide addition product.
Hetraline.	Resorcin compound.
Hexal.	Sulphosalicylate.
Hexamecol.	Guaiacol compound.

The above compounds are intended mostly as antiseptics or disinfectants, but bromalin has been used as a substitute for the alkaline bromides in the treatment of epilepsy.

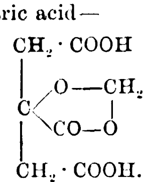
Formaldehyde is readily liberated from a certain type of ether-ester. These substances, discovered by W. A. Alberda van Ekenstein (*Proc. K. Acad. Amst.* 1900, 3. 400), contain the grouping—



and are produced by the action of formaldehyde on a-hydroxy-acids. The reaction is reversible and represented by the equation—



In this way citric acid gives the dibasic anhydromethylene-citric acid—



the sodium salt of which has been used under the name of "Citarine."

Formamol is the hexamethylene-tetramine salt of this acid. It is also known as Helmitol, Neurotropine, and Uropurgol. A mixture with hetraline is known as Citramine or Citraminoxyphen.

In the original process of making anhydromethylene-citric acid, formaldehyde solution was used and poor yields were obtained. These were subsequently improved by heating together a-hydroxy acid, trioxymethylene and chloroform for some hours at 150° (Lobry de Bruyn and van Ekenstein, *Rec. trav. Chim.* 1901, 20. 331). The preparation of anhydromethylene-citric acid, m.p. 205°, has also been described by W. Sternberg (*Pharm. Zeit.* 1901, 46. 1004).

Mesotan is methyoxymethyl salicylate ($C_6H_4(OH)COOCH_2OCH_3$), a yellow liquid with b.p. 162°/42 mm. It yields formaldehyde on hydrolysis (Eichengrün, *Pharm. Zeit.* 1902, 47. 857).

Methylene-ditannin (Tannoform)—$CH_2(C_{14}H_9O_9)_2$—is obtained by the action of hydrochloric acid on an aqueous solution of tannin and formaldehyde; it passes unchanged through the stomach, but tannin is liberated in the duodenum.

Glutol is a condensation product of gelatine and formaldehyde used as sheets or powder as an antiseptic dressing.

Acetaldehyde ($CH_3 \cdot CHO$, b.p. 21°). The older method of preparing aldehyde consisted in the oxidation of alcohol with chromic acid mixture. Sabatier and Senderens (*Compt. rend.* 1903. 136. 738, 922) found that alcohol could be actually "dehydrogenated" by passing its vapour over copper heated to 200° to 330°—

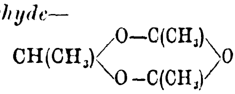
$$CH_3 \cdot CH_2OH = H_2 + CH_3CHO.$$

This reaction has proved capable of application on the large scale during the recent war.

The synthetic production of aldehyde by dissolving acetylene in sulphuric acid of sp. gr. 1·35, diluting with water and distilling (Lagermark and Eltekow, *Ber.* 1877, 10. 637) has been much improved by using a mercury salt as catalyst (Kutscherow, *Ber.* 1881, 14. 1540; 1884, 17. 13; Hofmann, *Ber.* 1898, 31. 2784. 1899, 32. 874).

Such application of catalysts made possible the production of aldehyde in very large amounts at the works at Shawinigan Falls (Canada).

Paraldehyde—



b.p. 125°, is used as a hypnotic. It is obtained by the polymerisation of aldehyde by hydrochloric acid, zinc chloride, etc.

Chloral—$CCl_3 \cdot CHO$, b.p. 97·7°—is official as the hydrate $CCl_3 \cdot CH(OH)_2$. Ethyl alcohol is chlorinated, the resulting chloral alcoholate decomposed by concentrated sulphuric acid and the free chloral combined with water.

Besson (D.R.P. 133021) recommends treating the product of the action of chlorine on alcohol in a gaseous state with moist chlorine.

Viferral is a polymerised chloral (C_2HOCl_3)x. obtained from chloral in presence of pyridine

(Gärtner, D.R.P. 165984). This hypnotic is a white powder which sinters at 150°, melts at 153-155°, and dissolves in hot water and alcohol, giving chloral hydrate and alcoholate respectively.

Chloralformamide (Chloramide)—$CCl_3 \cdot CH(OH)(NH \cdot CHO)$, m.p. 114–115°—is a slower hypnotic than chloral but is said to be safer. It is formed by the direct union of chloral and formamide.

Butyl Chloral Hydrate—$CH_3 \cdot CHCl \cdot CCl_2 \cdot CH(OH)_2$, m.p. 74–78°—is a weaker hypnotic than chloral obtained by the action of chlorine on paraldehyde or well cooled aldehyde. After dilution and neutralisation with calcium carbonate, the hydrate is distilled off and crystallised from water.

Ketone Derivatives.

Acetone—$CH_3 \cdot CO \cdot CH_3$, b.p. 56·5°—is chiefly of interest as an "intermediate" in the preparation of several drugs. It was formerly obtained from calcium acetate by distillation, but of late years use has been made of the observation that acetic acid distilled over a suitable catalyst yields acetone, water and carbon dioxide—

$$2CH_3COOH = CH_3 \cdot CO \cdot CH_3 + CO_2 + H_2O.$$

Methyl Ethyl Ketone—$CH_3 \cdot CO \cdot C_2H_5$, b.p. given variously between 78° and 81°—is obtained in the rectification of the products of wood distillation.

ββ - Bis - ethylsulphoneacetone (Sulphonal) —$(CH_3)_2C(SO_2C_2H_5)_2$—is a hypnotic, official in this country and in the United States.

When dry hydrogen chloride is passed into a mixture of 1 part of acetone and 2 parts of ethyl mercaptan, diethylthiodimethylmethane is produced (Baumann, *Ber.* 1885, 18, 887)—

$$(CH_3)_2CO + 2C_2H_5SH = H_2O + (CH_3)_2C(SC_2H_5)_2.$$

Baumann (*Ber.* 1886, 19. 2808) converted the compound into sulphonal by treatment with a 5 per cent. solution of potassium permanganate, dilute sulphuric acid being added from time to time. The mixture was heated and filtered, the filtrate then being concentrated. The sulphonal can be purified by recrystallisation from water or alcohol. Colourless prisms, m.p. 125° (127°–128° corr. Kempf).

Methylsulphonal (Trional) — $(CH_3)(C_2H_5)C(SO_2C_2H_5)_2$, m.p. 76°—acts more rapidly as a hypnotic; it is prepared from methyl-ethyl-ketone.

Ethylsulphonal (Tetronal)—$(C_2H_5)_2C(SO_2C_2H_5)_2$, m.p. 86°—is more soluble in alcohol than sulphonal.

For the use of ethylthiosulphuric acid in place of ethylmercaptan, see Bayer & Co. D.R.P. 46333.

Aliphatic Acids.

The aliphatic acids themselves will not receive any attention in this place, although formates are obtained synthetically from carbon monoxide, and acetic acid has recently been manufactured from calcium carbide by way of acetylene and acetaldehyde. The higher acids, both saturated and unsaturated, are usually derived from fats or by fermentation processes, so that our interest begins with the conversion of these acids into other substances.

Isovaleric Acid—$(CH_3)_2CH \cdot CH_2 \cdot COOH$—occurs as the bornyl ester in oil of valerian; the use of valerian and bromides in nervous troubles suggests the introduction of bromine into the valeryl group.

Bromoisovalerylcarbamide (Bromural)—$(CH_3)_2CH \cdot CHBr \cdot CO \cdot NH \cdot CO \cdot NH_2$—is stated to be a safe hypnotic.

Iodival—$(CH_3)_2CH \cdot CHI \cdot CO \cdot NH \cdot CO \cdot NH_2$—is the corresponding iodine compound, and may be used in many cases where iodides are generally employed.

a-Bromodiethylacetic acid gives rise to two hypnotics, the amide, *Neuronal*—$(C_2H_5)_2CBr \cdot CO \cdot NH_2$—and the ureide, Adalin—$(C_2H_5)_2CBr \cdot CO \cdot NH \cdot CO \cdot NH_2$.

Use has been made of bromine and iodine derivatives of the higher fatty acids to act as halogen carriers to the organism.

Calcium dibromobehenate (Sabromin) —$(C_{22}H_{41}O_2Br_2)_2Ca$—is a white powder without taste or smell. It is stated to be without action on the mucous membrane of the stomach and not to be absorbed before it reaches the intestine; consequently its use is recommended in cases of hysteria and other nervous affections.

Calcium monoiodobehenate (Saiodin)—$(C_{22}H_{42}IO_2)_2Ca$—is said to cause very slight or no iodism.

These halogenated behenic acids are obtained from erucic acid ($C_{22}H_{42}O_2$), which occurs as a glyceride in oil of hempseed, by the addition of halogen or halogen acid. In the case of monobromobehenic acid, the bromine may be replaced by iodine by warming with sodium iodide in glacial acetic acid solution, but a similar reaction cannot be carried out with the corresponding chloro-compound (Bayer and Co. D.R.PP. 180087, 186214, 186740, 187449, 187822, 215007, 215008, 215009).

For the amides and carbamides of higher

bromo- and iodo-aliphatic acids, see D.R.P. 248993.

Amino-acids.—It may be mentioned here that aminoacetic acid (glycocoll) possesses diuretic properties.

Cyclic Ureides.

The cyclic derivatives of carbamide frequently show very marked hypnotic action, veronal (diethylmalonylcarbamide) may be taken as typical of this class of compounds. The parent substance, barbituric acid, or malonyl-urea—

$$\begin{array}{c}\text{(6)}\quad\text{(1)}\\ \text{(5) } CH_2\left\langle\begin{array}{l}CO-NH\\CO-NH\end{array}\right\rangle CO \text{ (2)}\\ \text{(4)}\quad\text{(3)}\end{array}$$

was originally obtained from hydurilic acid and alloxantin, products of the action of nitric acid on uric acid.

The constitution was recognised from the fact that alkaline hydrolysis furnished malonic acid and urea, or, rather, the products of its fission. Confirmation of the structure was afforded by its synthesis which was effected by heating equal weights of malonic acid, urea and phosphoryl chloride to 100° (Grimaux, *Bull. Soc. Chim.* 1879, N.S. 31. 140).

$$CH_2(COOH)_2+(H_2N)_2CO = 2H_2O+CH_2\left\langle\begin{array}{l}CO-NH\\CO-NH\end{array}\right\rangle CO$$

Barbituric acid contains one atom of hydrogen replaceable by alkali metals, two atoms may be replaced by silver or lead. By acting on silver barbiturate with methyl iodide a dimethyl-barbituric acid was obtained which yielded dimethyl-malonic acid on hydrolysis (Conrad and Gutzeit, *Ber.* 1881, 14. 1643; Thorne, *Trans. Chem. Soc.* 1881, 39. 545). The compound was, moreover, quite different to the substance obtained by Mulder, who condensed malonic acid with *symm*-dimethylurea.

The constitution of the two isomerides is given by the formulae—

$$C(CH_3)_2\left\langle\begin{array}{l}CO-NH\\CO-NH\end{array}\right\rangle CO \qquad CH_2\left\langle\begin{array}{l}CO-N(CH_3)\\CO-N(CH_3)\end{array}\right\rangle CO$$

Conrad and Gutzeit also obtained a diethyl derivative from silver barbiturate and ethyl iodide (*Ber.* 1882, 15. 2849), which melts at 191° (182° C. and G.). Some years afterwards the hypnotic properties of this compound were recognised, and it was introduced under the name of veronal.

Barbitone (Veronal, Malourea, Malonal, Hypnogen) and its sodium derivative (Veronal-sodium, Medinal) enjoyed considerable popularity; its reputation has been somewhat damaged by the drug habit.

Proponal or Homalourea—

$$C(C_3H_7)_2\left\langle\begin{array}{l}CO-NH\\CO-NH\end{array}\right\rangle CO \qquad \text{and}$$

Luminal—

$$C(CH_3)(C_6H_5)\left\langle\begin{array}{l}CO-NH\\CO-NH\end{array}\right\rangle CO$$

were introduced at later dates, both being hypnotics.

Dibutylbarbituric acid is stated to combine pronounced sedative properties with but slight toxicity (Kamm and Vollweiler, U.S.P. 1331712).

Without entering into the merits or abuses of these hypnotics, it is worth considering at some length the synthetic methods by which they are produced, as illustrating the extensive research which is initiated by the introduction of a successful drug. Moreover, the methods and materials used in synthesising the 5,5-dialkylbarbituric acids warrant careful attention from their intrinsic chemical interest and their probable future use in synthesising other classes of compounds.

In place of carbamide, various related substances have been condensed with malonic or cyanoacetic derivatives, the carbonyl group of the urea portion of the nucleus being afterwards obtained as such. Thus Merck (D.R.P. 158591) condensed ethyl cyanoacetate with dicyandiamide—

$$CH_2\left\langle\begin{array}{l}CN\\COOC_2H_5\end{array}\right. + \left.\begin{array}{r}H_2N\\H_2N\end{array}\right\rangle C:N\cdot CN$$
$$= C_2H_5OH + CH_2\left\langle\begin{array}{l}C(:NH)-NH\\CO-\!\!-\!\!-\!\!-NH\end{array}\right\rangle C:N\cdot CN$$

and then hydrolised the resulting product to barbituric acid—

$$CH_2\left\langle\begin{array}{l}C(:NH)-NH\\CO-\!\!-\!\!-\!\!-NH\end{array}\right\rangle C:N\cdot CN + 4H_2O$$
$$= CH_2\left\langle\begin{array}{l}CO\cdot NH\\CO\cdot NH\end{array}\right\rangle CO + CO_2 + 3NH_3.$$

In subsequent processes it will be noted that the alkyl groups are generally introduced into the malonic or cyanacetic compound before condensation with carbamide or a substitute.

Bayer and Co. patented the following series of reactions—

$$CR_2\left\langle\begin{array}{l}CN\\COOC_2H_5\end{array}\right. + \left.\begin{array}{r}H_2N\\H_2N\end{array}\right\rangle C:NH$$
$$= C_2H_5OH + CR_2\left\langle\begin{array}{l}C(:NH)-NH\\CO-\!\!-\!\!-\!\!-NH\end{array}\right\rangle C:NH$$

D.R.P. 158592;

$$CR_2(CN)_2 + (H_2N)_2CS = CR_2\left\langle\begin{array}{l}C(:NH)-NH\\C(:NH)-NH\end{array}\right\rangle CS$$

D.R.P. 158621;

$$CR_2\left\langle\begin{array}{l}CN\\COOC_2H_5\end{array}\right. + (H_2N)_2CS$$

$$= CR_2\left\langle\begin{array}{l}C(:NH)-NH\\CO\text{------}NH\end{array}\right\rangle CS + C_2H_5OH$$

D.R.P. 162219;

and further (D.R.P. 165223) condensed ethyl malonate or cyanoacetate as well as malonitrile with dicyandiamide (X = NH or O)—

$$CR_2(COOC_2H_5)_2 \text{ or } CR_2\left\langle\begin{array}{l}CN\\COOC_2H_5\end{array}\right.$$

$$\text{or } CR_2(CN)_2 + (H_2N)_2C:N\cdot CN$$

$$\rightarrow CR_2\left\langle\begin{array}{l}CX\cdot NH\\CX\cdot NH\end{array}\right\rangle C:N\cdot CN.$$

For replacement of imino- or cyanimino-groups by oxygen, hydrolysis was resorted to, *e.g.* by boiling with 20 per cent. sulphuric acid, sulphur was removed by oxidation with nitric or nitrous acid or hydrogen peroxide. Einhorn (D.R.P. 165649) found that sulphur might also be replaced by oxygen by hydrolysis, whilst Meister, Lucius and Brüning (D.R.P. 170907), boiled with solutions of salts of heavy metals, *e.g.* lead acetate or copper chloride.

The imino-groups may also be removed by means of alkyl nitrites (Wolfes, D.R.P. 175592).

Merck also took patents for processes in which the alkyl groups were present in malonyl chloride before condensing it with derivatives of urea such as biuret or allophanic esters (D.R.P. 162220)—

$$CR_2(COCl)_2 + \begin{array}{l}H_2N\\HN\end{array}\!\!\left\rangle CO \right. \quad \searrow CO\cdot NH_2$$

$$= 2HCl + CR_2\left\langle\begin{array}{l}CO-NH\\CO\text{---}N\end{array}\right\rangle CO \quad N\searrow CO\cdot NH_2.$$

Other patents of Merck deal with the reactions—

$$CR_2\left\langle\begin{array}{l}CN\\COOC_2H_5\end{array}\right. + (H_2N)_2CO$$

$$= C_2H_5OH + CR_2\left\langle\begin{array}{l}C(:NH)\cdot NH\\CO\text{------}NH\end{array}\right\rangle CO$$

D.R.PP. 165561, 165562.

$$CR_2\left\langle\begin{array}{l}CN\\CN\end{array}\right. + (H_2N)_2C:NH$$

$$= CR_2\left\langle\begin{array}{l}C(:NH)-NH\\C(:NH)-NH\end{array}\right\rangle C:NH$$

D.R.PP. 165692, 165693.

$$CR_2\left\langle\begin{array}{l}CO\cdot NH\cdot CO\cdot NH_2\\CO\cdot NH\cdot CO\cdot NH_2\end{array}\right.$$

$$= CR_2\left\langle\begin{array}{l}CO-NH\\CO-NH\end{array}\right\rangle CO + CO\cdot(NH_2)_2$$

D.R.P. 174178.

A similar to the last is due to Traube—

$$CR_2(CO\cdot NH\cdot COOC_2H_5)_2$$

$$= CR_2\left\langle\begin{array}{l}CO\cdot NH\\CO\cdot NH\end{array}\right\rangle CO + CO(OC_2H_5)_2$$

D.R.PP. 172885, 172886.

Dicyandiamidine has also been used for condensations of this type (Von Heyden, D.R.P. 171147, Bayer and Co. 187990)—

$$CR_2(COOC_2H_5)_2 + \begin{array}{l}H_2N\\HN\end{array}\!\!\left\rangle CO \right. \quad \searrow C(:NH)(NH_2)$$

$$= 2C_2H_5OH + CR_2\left\langle\begin{array}{l}CO-NH\\CO\text{---}N\end{array}\right\rangle CO \quad N\searrow C(:NH)(NH_2)$$

Whilst Grimaux used phosphoryl chloride in his original synthesis of barbituric acid, reactions involving changes of types—

$$\cdot COOC_2H_5 + H_2N\cdot = C_2H_5OH + \cdot CO\cdot NH\cdot$$

$$CN + H_2N = \cdot C(:NH)\cdot NH\cdot$$

require the use of alkaline condensing agents. Alkali metals, their ethoxides, amides and cyanamides, and even calcium carbide, have been employed (Meister, Lucius and Brüning, D.R.P. 178934).

Dialkylmalonamides have also been directly condensed with phosgene (A.G. Anilinfabr. D.R.P. 167332) and with ethyl carbonate (Bayer and Co., D.R.PP. 168406, 168407).

The reaction—

$$CR_2\left\langle\begin{array}{l}COOR'\\CO-NH\end{array}\right\rangle \overset{NH_2}{\overset{|}{CO}} = R'OH + CR_2\left\langle\begin{array}{l}CO\cdot NH\\CO\cdot NH\end{array}\right\rangle CO$$

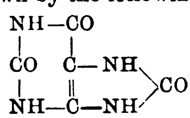
involves a complicated intermediate product (Boehringer, D.R.P. 193447).

Further alkylations of pyrimidine derivatives can only be mentioned (Schering, D.R.P. 174940; Einhorn, D.R.P. 193446).

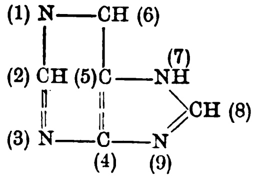
Chineosal is a trade name given to the quinine salt of diethylbarbituric acid.

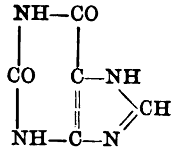
PURINE COMPOUNDS.

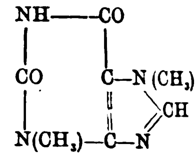
Xanthine, Caffeine, Uric Acid, etc., are all derivatives of urea; their relationships to one another and to Purine, their immediate ancestor, are shown by the following formulæ—

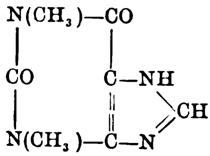


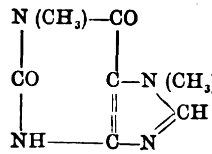
Uric acid.

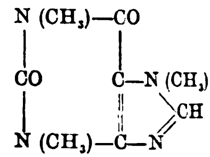

Purine.


Xanthine.


Theobromine.


Theophylline.


Paraxanthin.


Caffeine.

Derivatives of Purine have been used on account of their diuretic action, which is very slight in the case of xanthine, marked in the case of caffeine, and strongest with the dimethylxanthines. Of these, theophylline (Theocin) and paraxanthin are more effective than theobromine.

The solubility of theophylline and theobromine can be increased by the formation of double salts, which may be chosen to reinforce the desired properties. A few of these combinations may be mentioned—

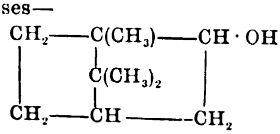
Euphyllin.	Theophyllin and Ethylenediamine.
Anisotheobromine.	Theobromine sodium and sodium anisate.
Agurin.	Theobromine sodium and sodium acetate.
Barutin.	Theobromine barium and sodium iodide.
Diuretin.	Theobromine sodium and sodium salicylate.
Eustenin.	Theobromine sodium and sodium iodide.
Theolactin.	Theobromine sodium and sodium lactate.
Theophorin.	Theobromine sodium and sodium formate.
Uropherin.	Theobromine sodium and lithium salicylate.

Paraxin is a synthetic product, being 1 : 7-dimethyl-8-dimethylaminoxanthin.

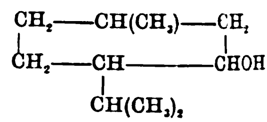
Derivatives of Cyclic Alcohols.

Three naturally occurring cyclic alcohols, borneol, menthol, and santalol, have found considerable uses—

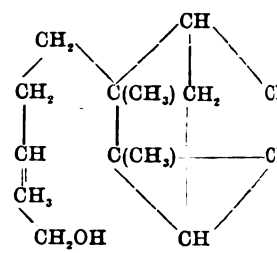
Borneol



Menthol



a-Santalol



The conversion of these alcohols into esters serves a twofold purpose, secondary reactions are avoided and the strong odour and taste are suppressed, or at any rate modified.

Bornyl isovalerate—$(CH_3)_2CH{\cdot}CH_2{\cdot}COOC_{10}H_{17}$—occurs in several oils (*e.g.* oil of valerian); the artificial ester, *Bornyval*, is used as a sedative and analeptic.

Bornyl isovaleryl glycolate—$C_4H_9{\cdot}COO{\cdot}CH_2{\cdot}COOC_{10}H_{17}$—is a colourless liquid, b.p. 42°/12 mm. It is almost without taste or odour, and is known as *New Bornyval.*

Bornyl a-bromoisovalerate (Valisan, Eubornyl)—$(CH3)_2CH{\cdot}CHBr{\cdot}CO_2{\cdot}C_{10}H_{17}$—is intended for use in nervous affections, *e.g.* neurasthenia and hysteria.

Bornyl aβ - dibromo - β - phenylpropionate (Adamon) — $(C_6H_5{\cdot}CHBr{\cdot}CHBr{\cdot}COOC_{10}H_{17})$ — has a sedative action, but is not hypnotic.

Tribornyl borate—$B(OC_{10}H_{17})_3$—is described by Zimmer and Co. (D.R.P. 188703), and Bayer and Co. obviate the intense odour of the three alcohols by conversion into alkyloxyacetic esters (D.R.P. 191547).

Menthyl isovalerate — $C_4H_9.COOC_{10}H_{19}$—is known as Validol.

Menthyl ethoxyacetate (Coryfin)—$C_2H_5{\cdot}O{\cdot}CH_2.COOC_{10}H_{19}$—and

Menthyl borate (Estoral)—$B(OC_{10}H_{19})_3$—are both used for nasal application.

Menthyl salicylate—$C_6H_4(OH)COOC_{10}H_{19}$—is known as Salimenthol.

Santalol (Arhéol, etc.). Sandalwood oil has enjoyed a considerable reputation as a disinfectant of the urinary passages, santalol being the active constituent. Hence esterification is useful in removing the inactive portion; the odour and taste are diminished and gastric irritation obviated or mitigated. The santalols may be obtained from East Indian sandalwood oil by heating with alcoholic potash, precipitating with water and rectifying under diminished pressure. For separating α- and β-santalols, Von Soden recommends conversion into the santalyl-phthalic acids and subsequent regeneration of the alcohols (*Arch. Pharm.* 1900, 238. 353).

Santalyl allophanate (Allosan)—
$NH_2{\cdot}CO{\cdot}NH{\cdot}COOC_{15}H_{23}$.

Santalyl carbonate (Blenal)—$CO(OC_{15}H_{23})_2$.

Santalyl camphorate (Camphoral)—
$C_8H_{14}(COOC_{15}H_{23})_2$.

Santalyl methyl ether (Thyreol)—
$C_{15}H_{23}, O{\cdot}CH_3$.

Santalyl salicylate (Santyl)—
$C_6H_4(OH)COOC_{15}H_{23}$.

The esters of these higher cyclic alcohols are prepared by a variety of methods: benzoates (Knoll and Co., D.R.P. 173240), isovalerates, stearates, etc. (Von Heyden, D.R.P. 182627), being obtained by the action of the acid chlorides in presence of pyridine. The carbonates and ethylcarbonates can be prepared in a similar manner, using phosgene or ethyl chlorocarbonate.

Salicylates are formed by heating with salol, phenol being eliminated; a small amount of sodium hydroxide is also added.

Mixed succinates and camphorates containing the methyl group have been introduced by Riedel (D.R.P. 208637), whilst Bayer and Co. have prepared carbonates containing menthyl or santalyl on the one hand and a salol or salacetol residue on the other.

Lecture II.—Delivered December 8th, 1919.

THE AROMATIC SERIES.

PHENOLS.

Phenol and its related compounds are largely used as antiseptics and disinfectants, whilst salicylic acid and its derivatives are used extensively in the treatment of rheumatic affections.

Phenol—C_6H_5OH—and its homologues are contained in coal tar, and are obtained from the first and second fractions of its distillation by extraction with alkali, separation by acid and rectification. In the last few years synthetic phenol has been very prominent as a source of picric acid for explosives. It is obtained by sulphonating benzene, isolating the product as sodium benzenesulphonate and fusing this salt with caustic soda.

Some ethers and esters of phenol may be mentioned.

Antodyne is the phenylether of glycerine—$CH_2(OC_6H_5){\cdot}CHOH{\cdot}CH_2OH$, m.p. 69°–70°—it has been introduced as a sedative.

Phenostal is diphenyl oxalate—$(COOC_6H_5)_2$—phenol is produced from it on hydrolysis.

Phenyform, a greyish white powder, for use in place of iodoform, is obtained from phenol and formaldehyde; it is said to be $C_6H_4(OH)(CH_2OH)$, $x\,CH_2O$.

Some of the simpler derivatives of phenol have found applications, *e.g.* *p*-chloro-phenol in dental surgery, and picric acid for burns.

Grotan is a name given to the sodium salt of chloro-*m*-cresol.

Attention may be drawn to a paper by Bechold and Ehrlich (*Zeit. physiol Chem.* 47. 173), who studied the action of halogenated phenols on diphtheria bacilli and various pathogenic bacteria. Generally, the introduction of halogen increases the activity; tetrabromo-*o*-cresol has a perceptible action on the organisms at a dilution of 1 in 200,000, whilst 1 in 800 is necessary with phenol. This particular compound is very slightly poisonous, but many halogenated phenols are as, or even more, poisonous than phenol itself.

Several derivatives of dihydroxybenzenes must be noticed.

Guaiacol—*o*-$C_6H_4(OH)(OCH_3)$—the monomethyl ether of catechol, occurs in beechwood tar, from which it can be extracted by a tedious process. Synthetic ways of preparing this compound are also known.

The valuable properties of beechwood creosote depend on the presence of guaiacol and its homologues; guaiacol, which is an antiseptic and deodorant, is used instead of creosote for internal administration in phthisis.

A number of esters derived from guaiacol have been introduced.

Phosphate—$PO(OC_6H_4OCH_3)_3$, m.p. 98°—from phosphoryl chloride and guaiacol sodium.

Carbonate (Duotal)—$CO(OC_6H_4OCH_3)_2$—is a tasteless, odourless, white, crystalline powder, m.p. 88°, obtained by the action of phosgene on a caustic soda solution of guaiacol.

The so-called creosote carbonate similarly obtained from creosote may be mentioned here.

Iso-Valerate (Geosote)—$C_4H_9 \cdot COOC_6H_4OCH_3$—is a liquid boiling between 245° and 265°.

Camphorate (Guacamphol)—$C_8H_{14}(COOC_6H_4OCH_3)_2$.

Benzoate (Benzosol)—$C_6H_5 \cdot COOC_6H_4OCH_3$, m.p. 50°–52°.

Cinnamate (Styracol)—$C_6H_5 \cdot CH : CH \cdot COO C_6H_4OCH_3$, m.p. 130°.

Monoiodo - guaiacol — 1 : 2 : 4-$C_6H_3(OH)(OCH_3)I$—has been used in chronic polyarthritis and pulmonary tuberculosis.

Resorcin—m-$C_6H_4(OH)_2$—possesses disinfectant properties; ointments are used containing this substance and zinc oxide. Resorcin is obtained by fusing sodium benzenedisulphonate with caustic soda. The monoacetyl derivative is known as *Euresol*.

Pyrogallol, being obtained from gallic acid, is hardly a synthetic substance; an oxidation product has been used in dermatological practice under the name of *pyraloxin*.

The two naphthols, $C_{10}H_7OH$, possess antiseptic properties; the benzoyl derivative of β-naphthol is employed under the name of *Benzonaphthol*. Tribromo-β-naphthol, m.p. 155°, is a disinfectant; the bromine atoms occupy the positions 1, 3, or 4 and 6 (Armstrong and Rossiter, *Proceedings of the Chemical Society*, 1891, 87).

A few more complicated phenolic compounds have been employed medicinally.

Purgen is the trade name for phenolphthaleïn—$C_{20}H_{14}O_4$—whilst *Aperitol* is a mixture of the alkyl and isovaleryl derivatives of phenolphthaleïn.

Phenol-Carboxylic-Acids.

Salicylic acid—$C_6H_4(OH)(COOH)$—is the most important of the hydroxy-aromatic acids, and was first obtained by the oxidation of saligenin and salicylaldehyde (Piria, *Annalen*, 1839, 30. 165). Subsequently it was found that the oil of different species of *Gaultheria* consisted chiefly of methyl salicylate (Löwig and Weidmann, *Pogg.* 1839, 46. 83; Köhler, *Ber.* 1879, 12. 246). The synthesis of salicylic acid was achieved by Kolbe and Lautemann (*Annalen*, 1860, 115. 201) by leading carbon dioxide over sodium phenoxide heated to 180°. Half the phenol distils over, the reaction following the course indicated by the equation—

$$2C_6H_5ONa + CO_2 = C_6H_4(ONa)(COONa) + C_6H_5OH.$$

Kolbe patented this process in 1877 (D.R.P. 426), protecting the use of the alkalies and alkaline earths.

R. Schmitt (*J. pr. Chem.* 1885, ii. 31. 397), explained the process as follows;—

$$C_6H_5ONa + CO_2 = C_6H_5 \cdot O \cdot CO \cdot ONa,$$
$$C_6H_5 \cdot O \cdot CO \cdot ONa = C_6H_4(OH)(COONa),$$
$$C_6H_4(OH)(COONa) + C_6H_5ONa = C_6H_5OH + C_6H_4(ONa)(COONa),$$

and patented a process (D.R.P. 29939) depending on the formation of the metallic phenyl carbonates which were then heated under pressure to 120°–140°, a salicylate being formed without the liberation of phenol. Other patents by Schmitt and von Heyden extend the reaction to substituted and homologous phenols, naphthols and hydroxyquinolines (D.R.PP. 31240 33635, 38052, 38742, 39662).

Hentschel (D.R.P. 24151) found that when diphenyl carbonate was heated to 200° in an indifferent atmosphere with sodium hydroxide or ethoxide, sodium salicylate was formed and phenol or phenetol distilled over.

This reaction was extended by Schering (D.R.P. 28985), who used sodium phenoxide, and by Hofmann and Schoetensock (D.R.P. 30172), who acted on sodium phenoxide directly with phosgene.

Marasse (D.R.PP. 73279 and 78708) heated phenol with potassium carbonate and carbon dioxide under pressure, and Schering (D.R.P. 133500) uses the mass obtained by fusion of sodium benzenesulphonate with caustic soda for conversion, as being especially suitable.

Various attempts have been made to oxidise orthocresol.

$$C_6H_4(OH)(CH_3) + 3O = H_2O + C_6H_4(OH)(COOH)$$

Lederer (D.R.P. 80747) protected the hydroxyl group by conversion into o-cresoxyacetic acid.

Friedländer and Löw-Beer (D.R.P. 170230) heat one part of o-cresol with five parts of caustic soda and five parts of copper oxide to 260°–270°, the excess of alkali protecting the hydroxyl group.

U. Pomilio (Brit. Pat. 103709) adds the cresol to 1 part of water and 5 to 6 parts of caustic soda, heats to 240°–260° and electrolyses with a current density at the anode (nickel, nickel-steel or iron) of 5–6 ampères per sq. dm.

The introduction of carboxyl by the use of carbon tetrachloride and soda (Reimer and Tiemann, *Ber.* 1876, 9. 1285) is technically useless in the original form; Zeltner and Landau (D.R.P. 258887) find that the reaction is much facilitated by the presence of copper or its salts.

Salicylic acid may also be obtained by heating o-chlorobenzoic acid with water and calcium hydroxide to 160°–170° (Boehringer, D.R.P. 288116).

Salicylic acid and its salts have been very extensively used, but not infrequently they give rise to gastric disturbances. By esterifying the carboxyl or acylating the hydroxyl, compounds are formed which pass the stomach more or less unchanged, but from which salicylic acid is liberated in the intestine.

The first artificial ester to be introduced was salol (Nencki and von Heyden, Brit. Pat. 8008 of 1886; D.R.PP. 38973, 43713, 46756, 57941, 68111, 70487, 70519), the preparation of this and other aryl salicylates being effected by heating salicylic acid with phenols or naphthols and phosphoryl chloride or phosphorus pentachloride.

$$2C_6H_4(OH)(COOH) + 2C_6H_5OH + POCl_3 = HPO_3 + 3HCl + 2C_6H_4(OH)(COOC_6H_5).$$

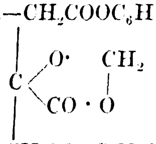
(For other processes, see Ernert, D.R.P. 62276; A.G. für Anilinf., D.R.P. 73452).

An objection to salol is that it yields phenol on hydrolysis, and a number of substances were introduced which give a less toxic compound than phenol when saponified.

Alphol—$C_6H_4(OH)(COOC_{10}H_7\alpha)$.
Aspirin—$C_6H_4(OCOCH_3)(COOH)$.

The British patent was subsequently rendered void, the compound having been first obtained by Gerhardt and recognised as acetylsalicylic acid by Kraut.

Benzosalin—$C_6H_4(OCOC_6H_5)(COOCH_3)$.
Betol—$C_6H_4(OH)(COOC_{10}H_7\beta)$.
Cordol—$C_6H_4(OH)(COOC_6H_2Br_3)$.
Diaspirin—$(CH_2 \cdot COOC_6H_4COOH)_2$.
Diplosal—$C_6H_4(OH)COOC_6H_4COOH$.
Glycosal—$C_6H_4(OH)COOC_3H_5(OH)_2$.
Methylaspirin—$C_6H_4(OCOCH_3)COOCH_3$.
Novaspirin—$CH_2COOC_6H_4COOH$



$CH_2COOC_6H_4COOH$.

Salacetol—$C_6H_4(OH)COOCH_2COCH_3$.
Salibromine—$C_6H_2Br_2(OH)COOCH_3$.
Vesipyrine—$C_6H_4(OCOCH_3)COOC_6H_5$.

Amongst salicylic compounds intended for external use, the following may be mentioned—

Mesotan—$C_6H_4(OH)COOCH_2OCH_3$,
Salit—$C_6H_4(OH)COOC_{10}H_{17}$,
Spirosal—$C_6H_4(OH)COOCH_2CH_2OH$, and
Salimenthol—$C_6H_4(OH)COOC_{10}H_{19}$.

(To be continued.)

ARTIFICIAL SILK INDUSTRY IN FRANCE.

The relative scarcity and high prices of silk and other textiles are at the bottom of a renewed interest that is being taken at present in the manufacture of the chemically-produced textile material known as artificial silk.

It was without any idea of filling a world demand that in 1855 Audemars, at Lausanne, Switzerland, took out his patent on a vegetable fibre for use in incandescent lamps. In 1884 the Count of Chardonnet discovered the collodion thread which he aspired to place alongside of silk in the textile world. But not until 1895 was it possible for the company which he founded to put on the market a thread which was denitrated and consequently less inflammable. Up to 1903 the new industry, interesting though it was, was not seriously regarded in the industrial world, but rather was considered in the light of an interesting novelty. In that year, however, the Société de la Viscose put on the market the artificial silk which until recently has been the last word in artificial textiles. It may be noted that this company is, in fact, a monopoly and controls the European market very effectively, selling or withholding its goods as it sees fit; only now has the widespread demand for chemical textiles encouraged lesser companies to undertake the manufacture of artificial silks.

On account of the substance which it employs (wood), the new industry has been enabled to adapt itself to any climate. Favoured by groups of Lyon merchants engaged in the French silk and textile industries, who did not hesitate to support the infant enterprise, it has become widely spread throughout the civilised world.

The production of artificial silk, which in 1902 was 2,000,000 kilos (4,408,000 pounds), rose successively to 5,000,000 kilos (11,020,000 pounds) in 1906, to 6,000,000 kilos (13,224,000 pounds) in 1912, and to 8,000,000 kilos (17,632,000 pounds) in 1914. Germany's production of this article is estimated at 5,000 kilos (11,020 pounds) daily; and France, when the new installations of machinery are completed and material more easily obtainable, will be capable of putting out some 4,000 kilos (8,816 pounds) per day. As in other French manufactures, the lack of fuel and the embarrassed transportation services are more serious obstacles than any lack of raw material. While it is impossible to estimate with exactness the total production for 1919, it was assuredly great, but far below the demand.

Progress was checked by the war, while at the same time the demand for the products of the industry was greatly augmented on account of the paucity of all textiles. In spite of the fact that viscose silk is extremely inflammable and cannot resist humidity, uses for it were numerous, during the war, to replace other materials; and it was even found possible to make use of it directly in war work. At Lyons, a cellulose-textile factory, serving as a plant for producing explosives, made

sacks of artificial silk to hold powder; and certain parts of the anti-asphyxiation masks used on the front were also made of this cloth.

It is worth noting that the increasing activity of the artificial-textile industry, far from coming into competition with that of the natural silk, coincides with and supplements the growth of the latter. The production of natural silk increased from 19,000,000 kilos (41,876,000 pounds) in 1904 to 23,000,000 kilos (50,692,000 pounds) in 1906, to 27,000,000 kilos (59,508,000 pounds) in 1912, and only dropped to 22,000,000 kilos (48,488,000 pounds) in 1914 because of the war. The difficulty experienced by natural-silk weavers in procuring sufficient material, and the top prices it commands, provide abundant proof that natural silk is more than ever in demand and has nothing to fear from what, at most, is a distant competitor. Viscose silk cannot be obtained in the really fine grades; its use is restricted, for the most part, to such uses as do not subject it to fire and water. In short, taking into consideration that natural silks cannot supply the market, the artificial silk supplements the natural product, but does not compete with it except in the lower grades.

According to a report prepared at the United States Consulate at Lyons, a renewed impetus was recently given to the use of chemical textiles by the invention of an entirely new process, the product of which is called silk cellulose. This new form of cloth is claimed to possess a brilliancy comparable to silk schappe, a remarkable solidity and durability, a touch similar to silk, and absolute imperviousness to water; at the same time it is no more endangered by fire than the ordinary natural silks. While the thread of the viscose silks is, of necessity, relatively coarse and thick, the new silk permits of making threads of considerable fineness, and is particularly remarkable for the quality of the velvets which can be made from it. The new process differs radically from the old processes. Instead of converting a thick liquid (the viscose) into thread, it appears that it is possible to preserve the wood fibres and convert them into a brilliant and solid cellulose. As a result of this there is obtained a greater molecular concentration and a regular geometric form in the elements that make up the thread; all of which, it is claimed, greatly increases the strength and durability of the cloth.

A large factory for the production of the new textile is being projected for large-scale commercial production in the Lyons district, where such materials as velvets, jerseys, satins, draperies, linings, and other silk goods will be woven. Although artificial silks can already be obtained at very advantageous prices as compared with natural silk, the inventor of the new process claims that his product will be able to reduce still further the cost of chemically-produced threads.

Despite the fact that for years to come the artificial textile may not compete with natural silk, yet the producers of the latter must eventually look for advances and inventions on the part of chemists that may ultimately remove the defects now so obvious in the viscose silks. What is most needed is ability to spin a much finer thread, which is at present extremely difficult on account of the air which is held in the coagulating bath in which the artificial threads are formed. Seven or eight years hence, when there has been time for a surplus of artificial silk to accumulate on the market, by reason of the establishment of new plants and increased production of other textiles, those whose interests are bound up in the artificial silk industry will be forced to bring about new developments in order to enable it to hold its place; at that time real competition may be looked for between natural and artificial silks.

The following data have been made public as technical means for determining the various sorts of artificial silks:—Sulphuric acid glycerinated: pure glycerine, 10 cubic centimetres; distilled water, 5 cubic centimetres; concentrated sulphuric acid, 15 cubic centimetres. Iodo-ioduret of potassium: iodide of potassium, 0·3 gramme; water, 30 cubic centimetres; iodine in excess. Chloro-ioduret of zinc: chloride of zinc, melted, 1·75 grammes; water, 30 cubic centimetres; iodine to saturation. Concentrated sulphuric acid; chromic acid, half saturated; solution of caustic potash at 40 per cent.; ammoniacal copper oxide: ammoniacal nickel oxide; a glycerinated and alkaline solution of copper. An acid solution of diphenylamine: diphenylamine, 1·57 grammes; concentrated sulphuric acid, 25 cubic centimetres.

The ammoniacal preparation of copper oxide is prepared by dissolving the copper oxide in ammonia in saturation, then passing through the solution a current of air from which the moisture has been removed by passing through a solution of caustic potash.

The ammoniacal solution of nickel oxide is prepared by dissolving 2 grammes of nickel sulphate (crystallised) in 30 grammes of water, precipitating the nickel by means of caustic soda, filtering, and then redissolving the precipitate in ammonia. The alkaline and glycerinated solution of copper is prepared by dissolving 3 grammes of copper sulphate in 30 cubic centimetres of water, with 1·75 grammes of pure glycerine, then adding enough caustic potash to precipitate the copper, and redissolving.

There are five kinds of artificial silk: Nitrated silks, collodion silks, the viscose silks, the acetate silks, and gelatine silks.

In calcinating a fragment of the silk in a small test tube, in the upper part of which has been placed a piece of red litmus-paper, the calcination, in the event of the silk being of the gelatine variety, will produce ammonia vapours which will turn the paper blue. There should be, further, the familiar odour of burnt horn. When calcinated, the four other kinds of silks emit vapours which turn the blue paper red.

The silk of the acetate variety, when treated

with glycerinated sulphuric acid, takes on a yellow colour with iodo-ioduret of potassium and also with the chloro-ioduret of zinc.

The silks of nitrocellulose, of the viscose silks, dissolve rapidly in sulphuric acid concentrated cold; the cellulose silks dissolve slowly. All three dissolve little by little in cold chromic acid, and rapidly if the acid be heated. The three, and the acetate silks as well, swell up in a solution of caustic potash; while in the same solution the gelatine silk dissolves rapidly and completely.

In the ammoniacal solution of copper oxide, the collodion and viscose silks begin by slowly swelling and then dissolving; while the acetate silks swell without dissolving, and the gelatine silk turns a bluish violet and does not dissolve.

With ammoniacal oxide of nickel the artificial silks swell without dissolving, except that the gelatine silk turns brown without dissolution or swelling.

The glycerinated and alkaline solution of copper does not have any effect on the artificial silks even after a prolonged boiling, excepting upon the gelatine silks, which are rapidly dissolved.

The solution of diphenylamine gives a pure blue colouration to the nitrocellulose silks alone; the colouration is most intense at the end of five minutes and fades little by little thereafter.

Care should, of course, be taken to make tests at the same time with silks of known varieties for purposes of checking and comparison. Should the silks have been dyed, the colour should be taken out with hydrosulphite.

VEGETABLE OILS IN PALESTINE.

The vegetable oils of Palestine are of two varieties—sesame and olive. In pre-war times both varieties were exported to a moderate extent, the preponderance being in favour of the olive oil.

During the Turkish *régime* sesame oil was used for lubricating purposes on the military railways, the result being that nearly the entire product had been used up before the British occupation. Another reason that helped to lessen the quantity of this oil was that, in view of the shortness of breadstuffs for the Army, the peasants were ordered to plant millet as a summer crop instead of the sesame. This error was later realised by the Turkish authorities when lubricating oil was much needed and unobtainable.

According to a report by the United States Consul at Jerusalem, the olive-oil industry suffered a severe setback during the war, from which it will take at least fifty years to recover. With the allied blockade of Turkish ports, wood for the railways had to be substituted for coal, and in Palestine the olive trees were required to bear the greater part of this substitution. The trees were cut down in the districts through which the railways ran, and it is estimated that half the olive trees were destroyed in this manner. Again, while retreating, the Turks mutilated the small branches of the olive trees for quick fuel. The destruction was further increased by the fact that most of the battles on this front took place in the olive-grove districts, and consequently the land around the trees could not be ploughed at the proper time and they will not yield advantageously, unless they are properly cultivated for at least two consecutive years. In addition to this war devastation, the locust plague in 1915 materially injured the trees.

It will be noted from the foregoing that the vegetable-oil industry in Palestine has suffered very severely during the last five years. At present these oils are very rare and their prices consequently greatly advanced.

In the manufacture of sesame oil the seeds are first soaked for a period and then beaten with large mauls in order to separate the outer shell from the kernel. Then the seeds are placed in a primitive oven, and later are ground between two flat stone discs turned by a camel or a mule, and the thick, pulpy fluid which flows from it is poured into a deep vat.

Of late years some European machines have been imported, but have not as yet, except to a very small extent, displaced the primitive method.

Sesame oil is used for cooking by almost the entire Jewish population, as the orthodox may not use butter fats with meat cooking. It is also generally used by the poor.

Most of the olives are now made into commercial oil—that is, for soap-making—and no great care is taken to turn out first-class table or salad oil. The olives when picked are poured into great piles and are left to wilt by overheating. This has the effect of producing the greatest possible quantity of oil which can be extracted by such a primitive method.

The olives are crushed by a large stone disc, which rotates on its edge. When crushed they are packed into goat-hair sacks or in special baskets and poured into an iron press. There are two types of such presses in use, one known as the French, and the other as the Greek. These machines were first imported from Europe, but latterly were extensively made in a German foundry at Jaffa. Since the occupation, a British firm has taken over the foundry and is again supplying these hand-power machines.

CORRESPONDENCE.

OIL RESOURCES OF THE BRITISH EMPIRE.

In reference to Sir John Cadman's exceedingly valuable paper on "The Oil Resources of the British Empire," I should like to say that it is impossible to foresee the future as regards mechanical inventions. Every practical engineer admits the great

advantages of oil fuel, not only for ships of war, but also for the great Atlantic liners. On the other hand, he would be a bold man who said that no substitute for oil fuel would ever be brought into practical use. May I suggest that the Low engine which was made and worked some years ago indicates the possibility that coal reduced to the condition of dust may some day be used for internal combustion engines, which might possibly consume less fuel per horse-power than the present marine engines where oil is used as a fuel for steam boilers?

May I also suggest the possibility that coal dust might be used on board ships as a fuel for steam boilers as a substitute for oil? I admit that the machinery for conveying the coal dust to the ship's boiler furnaces has yet to be invented, but a long-continued high price of oil and an increasing demand for fuel that will do the work that is now done by fuel oil is likely to lead to inventions for utilising coal of which there are such abundant stores.

ARNOLD LUPTON.

With regard to the above communication, it is understood that no definite results so far arrived at are calculated to remove such a suggested substitute from the region of doubt, or to encourage the hope that we are within measurable distance of the replacement of oil fuel by coal dust. It has been demonstrated, however, that a fuel oil and coal dust can be used in combination. In a most valuable lecture delivered by Sir Frederick W. Black, K.C.B., B.A. (Lond.), at a meeting of the Institution of Petroleum Technologists held at the Crystal Palace on June 3rd, the lecturer stated that another hopeful direction for economy of heavy oil fuel lay in the combination of oil with finely pulverised coal, in what was known as colloidal form. An admixture of coal dust up to about 33 per cent. had been found admissible for marine purposes, and up to 50 per cent. for use on land. Practical and technical difficulties still had to be overcome in keeping the coal in prolonged suspension in the oil in ships' tanks, and when, in the near future, as appeared probable, those difficulties were finally surmounted, the area of use of liquid fuel in ships would have been widely extended.

GENERAL NOTES.

A PASSAVENT CARPET.—Mr. A. F. Kendrick, of the Department of Textiles, Victoria and Albert Museum, sends the following account of a carpet made by Passavent, of Exeter (to whom the Society granted a premium in 1758), which was sold at Christie's for 750 guineas on June 29th. It now measures 15 ft. by 12 ft. 5 in. The ground is pale blue, with a pattern of acanthus foliage, baskets of flowers, garlands and parrots. There is an outer *contrefond* in black. In the middle of the carpet is a realistic representation of a dog on a cushion. The border is pale blue, with a pattern of shells, masks, acanthus foliage and floral stems. The workmanship is excellent, the surface being very level and smooth. The colours were good, and are still, for the most part, finely preserved. Along one border the inscription "EXON: 1757" is knotted in two-inch letters of a pale brown colour. In regard to the technique, the warp is of white wool, lying in two levels. Every twentieth warp is brown—probably to facilitate counting. The weft is of coloured wool. There are two shoots after each row of knots. The pile is of wool. A knot, known as the "Ghiordes" knot, is the one used. This knot is the most generally found of all those used in the East. There are about eighty knots to the square inch.

FUEL FOR MOTOR TRANSPORT.—The Fuel Research Board of the Department of Scientific and Industrial Research have prepared an interim memorandum on fuel for motor transport, which has been published by H.M. Stationery Office for the Department. The memorandum deals chiefly with the possibility of the substitution of power alcohol for petrol as a motor fuel, and is divided into three sections: (1) Historical; (2) The Present Position of Power Alcohol; (3) Alternative Motor Fuels. Copies of the memorandum, price 3d., may be obtained through any bookseller, or directly from H.M. Stationery Office.

BRITISH EMPIRE EXHIBITION.—In the House of Commons on August 8th, Mr. Kellaway (Overseas Trade Department) moved: "That it is expedient to authorise the payment out of moneys provided by Parliament of any sums not exceeding £100,000 required for the fulfilment of any guarantee against loss resulting from the holding of a British Empire Exhibition given by the Board of Trade." He explained that the idea of the exhibition originated with the late Lord Strathcona, that the guarantee would only become operative if a guarantee of £500,000 was forthcoming from private sources, and that the money would not in any case be payable until 1923. After a discussion, the motion was agreed to.

IMPROVED MINE RESCUE METHODS AND APPARATUS.—The Mine Rescue Apparatus Research Committee of the Department of Scientific and Industrial Research have presented their second report to the Advisory Council of the Department, on whose recommendation it has now been published. The work described in the report relates chiefly to experimental results obtained during the last two years since the publication of the Committee's first report, and to the description of new or improved mine rescue methods and apparatus which are the outcome of the investigation. The report is divided into four parts:— I. Physiological considerations and experiments; II. Deaths due to rescue apparatus; III. Approval of mine rescue apparatus; IV. Miscellaneous; and two appendices are included, I. The Briggs' compressed oxygen mine rescue apparatus; II. Fitness testing with the ergometer. Copies of both the first and second report of the Committee (price 1s. 9d., by post 1s. 11d., and 2s., by post 2s. 2d. respectively), may be obtained directly from H.M. Stationery Office.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

SYNTHETIC DRUGS.

By JOHN THEODORE HEWITT, M.A., D.Sc., Ph.D., F.R.S.,

Emeritus Professor of Chemistry, East London College.

Lecture II.—Delivered December 8th, 1919.

THE AROMATIC SERIES.

PHENOLS.

(Continued from page 635.)

Aromatic amines and their derivatives.

Aniline and homologous amines have a distinct effect in lowering the temperature, but their use in an unmodified condition is rendered impossible by their toxic properties. The latter are twofold: the motor centres of the midbrain are paralysed and vertigo results, and, in addition, the hæmoglobin is attacked. The higher homologues differ qualitatively, and the position of the substituent groups makes a considerable difference. Metatoluidine closely resembles aniline. Ortho- and para-toluidine are much milder in their effects, whilst in benzylamine the antipyretic action nearly disappears.

By acylating the aromatic amines, substances are obtained which are more resistant in the circulation, but which still possess antipyretic properties. The observation that acetanilide is oxidised in the body and hydroxyl introduced in the para position, and further, that para-aminophenol, whilst a strong antipyretic, is much less toxic than aniline, points to the use of a derivative of para-aminophenol protected in such a way as not to attack the red blood corpuscles. Acetylation of the amino-group does something, but even better results are obtained if the hydroxyl group is ethylated; the resulting compound, *p*-ethoxyacetanilide, commonly known as phenacetin, being a much used substance.

Paramethoxyacetanilide, Methacetin, is less satisfactory, though it has a maximum antipyretic action; the higher alkyl groups render the molecule too inactive.

A number of substituted anilides have been introduced as antipyretics under trade names—

Antifebrin—$C_6H_5NHCOCH_3$.

Exalgin—$C_6H_5N(CH_3)COCH_3$.

Cosaprin—$C_6H_5(NHCOCH_3)SO_3Na$.

Amygdophenin—
$C_2H_5OC_6H_4NH\cdot CO\cdot CHOH\cdot C_6H_5$.

Apolysin—
$C_2H_5OC_6H_4\cdot NH\cdot CO\cdot C_3H_5(COOH)_2$.

Eupyrine—
$C_2H_5OC_6H_4\cdot NHCO\cdot C_6H_3(OCOOC_2H_5)(OCH_3)$.

Kyrofin—$C_2H_5O\cdot C_6H_4\cdot NH\cdot COCH_2OCH_3$.

Lactophenine—
$C_2H_5O\cdot C_6H_4\cdot NH\cdot CO\cdot CHOH\cdot CH_3$.

Malakin—$C_2H_5O\cdot C_6H_4\cdot NH\cdot CO\cdot C_6H_4\cdot OH$.

Phenocoll—
$C_2H_5O\cdot C_6H_4\cdot NH\cdot CO\cdot CH_2\cdot NH_2, HCl$.

Pyrantin— $\begin{matrix}CH_2CO\\ |\\ CH_2CO\end{matrix}\!\!>N\cdot C_6H_4\cdot OC_2H_5$.

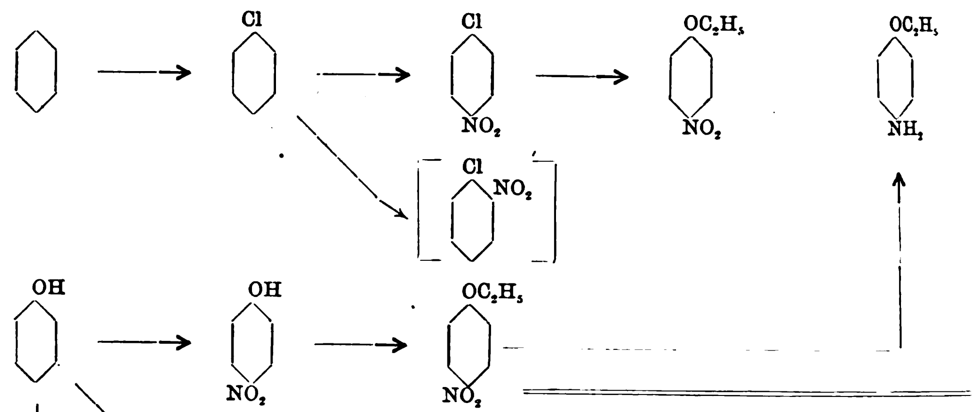
Salophen—
$C_6H_4(OH)COO\cdot C_6H_4\cdot NH\cdot CO\cdot CH_3$.

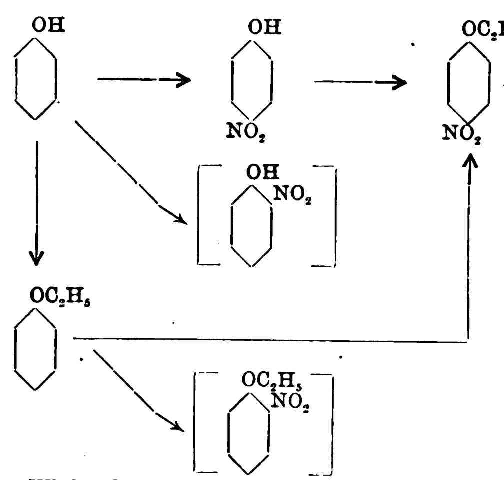
Triphenine—$C_2H_5O\cdot C_6H_4\cdot NH\cdot CO\cdot C_2H_5$.

Thermodine—
$C_2H_5O\cdot C_6H_4N(COOC_2H_5)(COCH_3)$.

Valerydine—$C_2H_5O\cdot C_6H_4\cdot NH\cdot CO\cdot C_4H_9$.

Regarding the preparation of substances of this type, we may confine ourselves to phenacetin and the phenetidine from which it is derived by acetylation. Whether we start with benzene or phenol, we must at some stage obtain a mixture of ortho and para isomerides, and discard the former.





Whilst the route appears shorter if we start with phenol, the separation of *p*-nitrophenol is so troublesome that it is preferable to make it from *p*-nitroacetanilide by alkaline hydrolysis. In nitrating phenetole, the production of dinitrophenetole (Cahours, *Annalen*, 1850, 74. 315) must be avoided, so that an adaptation of Willgerodt's process (*Ber.* 1882, 15. 1002), viz. boiling *p*-chloronitrobenzene with water, alcohol and caustic potash appears most promising.

Aromatic Acids.

Many derivatives of benzoic acid and amino-alcohols have been introduced as local anæsthetics. Amongst naturally occurring products we have cocaine, an alkaloid found together with ecgonine and other derivatives in the leaves of *Erythroxylon coca.* Atropine, which may be hydrolysed to tropine and tropic acid, is closely related, in fact all these compounds are derivatives of tropine itself. Their relationships are shown in the following table:—

```
CH₂—CH——CH₂
|    |    |
|   NCH₃ CHOH
|    |    |
CH₂—CH——CH₂
```
Tropine (not mydriatic).

```
CH₂—CH——CH₂
|    |    |
|   NCH₃ CH·OCO·CH·C₆H₅
|    |    |      |
CH₂—CH——CH₂    CH₂OH
```
Atropine (mydriatic).

```
CH₂—CH——CH₂
|    |    |
|   NCH₃ CHOH
|    |    |
CH₂—CH——CH·COOH
```
Ecgonine (not anæsthetic).

```
CH₂—CH——CH₂
|    |    |
|   NCH₃ CHOH
|    |    |
CH₂—CH——CH·COOCH₃
```
Methylecgonine (not anæsthetic).

```
CH₂—CH——CH₂
|    |    |
|   NCH₃ CH·OCOC₆H₅
|    |    |
CH₂—CH——CH·COOCH₃
```
Cocaine (anæsthetic)

```
CH₂—CH——CH₂
|    |    |
|   NCH₃ CH·OCO·CH : CH·C₆H₅
|    |    |
CH₂—CH——CH·COOCH₃
```
Methylcinnamylecgonine (not anæsthetic).

We can, in a sense, include cocaine as a synthetic drug, since the alkaloids of coca. which show no anæsthetic action, may be utilised. Ecgonine can be produced, and then methylated and benzoylated. It may be remembered that the benzoyl derivatives of morphine, quinine, etc., behave to some extent as local anæsthetics.

It is desirable that a local anæsthetic should stand boiling in solution. Cocaine is prone to hydrolyse under these conditions, and its toxicity and action as an irritant are also against it.

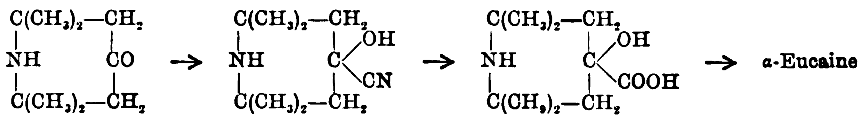
Some of the synthetic drugs, with constitutions resembling that of cocaine, are more reliable in these respects.

a-Eucaine—$C_{19}H_{27}O_4N$—

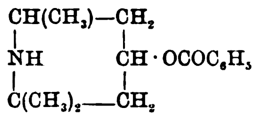
```
CH₃—C(CH₃)—CH₂
     |       |  /OCOC₆H₅
     NH      C<
     |       |  \COOCH₃
CH₃—C(CH₃)—CH₂
```

is less toxic than cocaine and its solutions can be sterilised by boiling; unfortunately it is irritant.

Ammonia is condensed with acetone to diacetoneamine, and the latter with more acetone to triacetoneamine. From this compound the cyanhydrin is formed which is hydrolysed to an α-hydroxy acid, the latter being methylated and benzoylated.



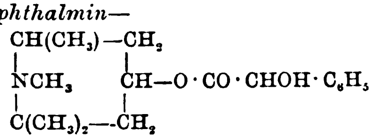
β-Eucaine—$C_{15}H_{21}O_2N$—is official as *Benzamine lactate*; its structure is given by the formula—



In synthesising the compound, diacetoneamine is condensed with aldehyde (or paraldehyde) to give vinyl-diacetoneamine, and this is reduced to the corresponding secondary alcohol. Obtained in this manner, it melts at 123°. The product is really a mixture of stereoisomerides melting at 137°–138° and 160°–161° respectively. It is from the labile (*cis*-) form that the active derivative is obtained.

The effect as a local anæsthetic would appear to depend to some extent on the benzoyl group, for in

Euphthalmin—



one has a substance which possesses mydriatic but not anæsthetic properties.

The essential groups in the local anæsthetics considered appear to be a secondary or tertiary amino-group, and a benzoylated secondary or tertiary carbinol. The substances so far considered contain the amino- and carbinol-groups as members of a 6-ring, but is this 6-membered ring essential? Fourneau (*Compt. rend.* 1904, 138. i. 766) tried benzoylating open-chain amino-alcohols, and found that certain of these could act as local anæsthetics.

Stovaine — $CH_3\cdot C(C_2H_5)(OCOC_6H_5)CH_2\cdot N(CH_3)_2$,HCl—was obtained by Fourneau by acting on dimethylaminoacetone with ethyl magnesium bromide; the resulting tertiary alcohol was benzoylated.

Alypin—$(CH_3)_2N\cdot CH_2\cdot C(C_2H_5)(OCOC_6H_5)\cdot CH_2\cdot N(CH_3)_2$, HCl—differs from stovaine in containing an extra dimethylamino-group (D.R.P. 173610).

Novocaine—$NH_2\cdot C_6H_4\cdot COO\cdot CH_2CH_2\cdot N\cdot(C_2H_5)_2$, HCl (compare, *Annalen*, 1910, 371. 125)—has met with much success. Diethylamine and ethylene chlorhydrin react to give diethylamino-ethyl alcohol, and the latter compound gives a *p*-nitrobenzoic ester when treated with *p*-nitrobenzoyl chloride. By reduction of the nitro-group, novocaine is obtained.

A modification (D.R.P. 180292) consists in the reduction of the azobenzoic alkamine ester which can be obtained either from azobenzoic acid or azobenzoyl chloride.

Anæsthesin — $NH_2C_6H_4COOC_2H_5$ — is even simpler in constitution. *Subcutin* is its phenol-*p*-sulphonate.

Propæsin and *Cycloform* are the corresponding propyl and isobutyl esters of *p*-aminobenzoic acid.

Nirvanin is $C_6H_3(\overset{1}{C}OOCH_3)(\overset{2}{O}H)(NH\overset{3}{C}OCH_2N)(C_2H_5)_2$.

Orthoform is methyl-*p*-amino-*m*-hydroxybenzoate, in *Orthoform new*, the hydroxyl and amino groups are interchanged.

Holocaine—$CH_3\cdot C\left\langle\begin{matrix} N\cdot C_6H_4OC_2H_5 \\ NH\cdot C_6H_4OC_2H_5\end{matrix}\right.$, HCl—is somewhat toxic.

Acoine — $C\left\langle\begin{matrix} N\cdot C_6H_4OC_2H_5 \\ (NH\cdot C_6H_4OCH_3)_2\end{matrix}\right.$, HCl—is a derivative of guanidine, and apparently less toxic than cocaine.

Lecture III.—Delivered December 15th, 1919.

Quinoline Derivatives.

The recognition of the quinoline nucleus in quinine drew attention more than thirty years ago to the possibility of using quinoline derivatives as drugs. Several of these possess antipyretic properties; in other respects they are unsatisfactory, and interest in them is chiefly historical.

Kairoline.—This name was given to the acid sulphates of tetrahydroethylquinoline (Kairoline A), or tetrahydromethylquinoline (Kairoline B). These bases were obtained by Koenigs

and Hofmann by the reduction of ethyl or methyl quinolinium salts.

Kairine (O. Fischer, D.R.P. 21150) was obtained by reduction of *o*-hydroxyquinoline and subsequent alkylation.

Thallin is strongly antipyretic but toxic.

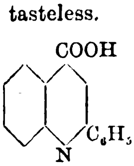
O-*Hydroxyquinoline* has its uses as a disinfectant. *Chinosol*, which was supposed to be potassium hydroxyquinoline-sulphonate, turned out to be a mixture of the sulphates of the base and potassium.

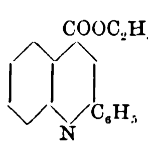
Oxychinaseptol or *Diaphtherin* is the phenol-*o*-sulphonate of *o*-hydroxyquinoline.

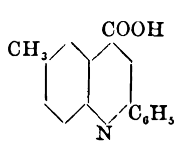
Atophan—2 - Phenylquinoline - 4 - carboxylic acid, m.p. 208°-209°—promotes the excretion of uric acid, and is consequently used in the treatment of gout and acute articular rheumatism.

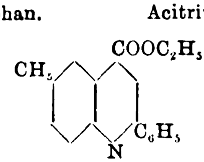
Acitrin—m.p. 60°-61°—is the ethyl ester of the preceding acid. Its action is similar, but the excretion of uric acid begins later.

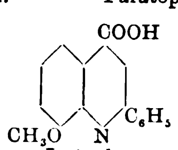
Paratophan and *Novatophan* are higher homologues of the above; *Isatophan* is a methoxy derivative of atophan. Whilst atophan is bitter, isatophan and novatophan are tasteless.


Atophan.


Acitrin.


Paratophan.


Novatophan.

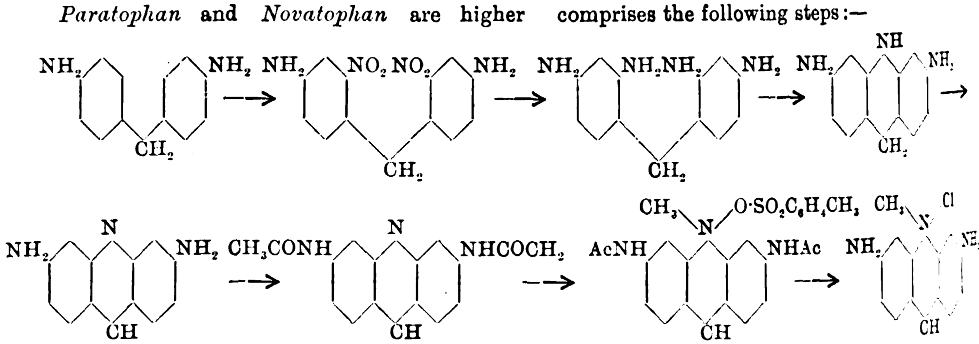

Isatophan.

Acridine Derivatives.

The derivatives of 2:8–diaminoacridine have received considerable attention in the last two years on account of the properties of 10-methyl-2:8-diaminoacridinium chloride. Benda (*Ber.* 1912, 45. 1787) first prepared this compound at Ehrlich's suggestion, and experiments on mice showed that it possessed strong trypanocidal action; it was in fact three times as active as the corresponding compound obtained from acridine yellow (3:7-dimethyl-2:8-diaminoacridine). It was also tried on man and found to produce a distinct effect in sleeping sickness.

Further interest in the compound (Trypaflavine, Flavine, Acriflavine, Proflavine) was aroused by the observations of Browning, Gulbransen, Kennaway, and Thornton (*British Medical Journal*, 1917, i. 73; see also *Proceedings of the Royal Society*, 1918 (B), 90. 136). Most antiseptics act more powerfully in water than in blood serum, but the reverse holds for Flavine, *Staphyllococcus aureus* being killed at a dilution of 1 in 20,000 of water containing 0·7 per cent. of peptone, but at 1 in 200,000 in blood serum. For *Bacillus coli* the respective figures are 1:1,300 and 1:100,000. Flavine has, moreover, a low toxicity.

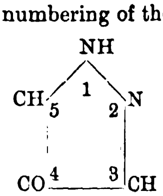
Benda's method of preparing the compound comprises the following steps:—

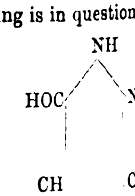


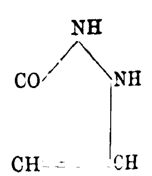
The successful preparation of diaminoacridine from *m*-phenylenediamine and formic acid has been claimed recently (Poulenc Frères & Meyer. Brit. Pat. 137214).

Pyrazolone Derivatives.

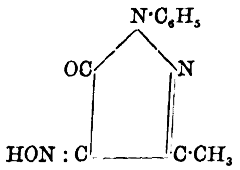
Of the pyrazolone derivatives the most important is *antipyrine* or phenazone. The pyrazolone compounds exhibit tautomerism; this has to be kept in mind, especially when the numbering of the ring is in question.


I.

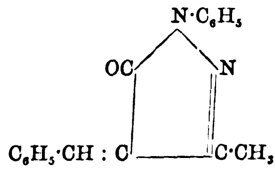

II.


III.

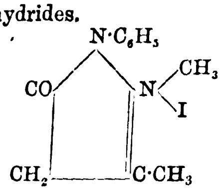
The preparation of phenylmethylpyrazolone leads to a formula for the substance corresponding with Constitution I., and it appears to agree well with the formation of isonitroso and benzylidene compounds which may be formulated as



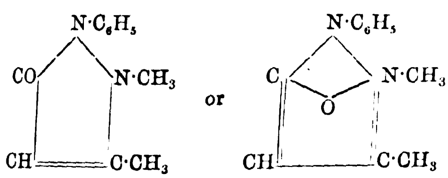
and



respectively. The solubility in alkalies corresponds better with Structure II., whilst the anhydro-bases (*e.g.* antipyrine) obtained by the addition of alkyl halides and removal of the elements of hydrogen halide agree either with Structure III. or must be formulated as internal anhydrides.



Antipyrine hydrodide.



Antipyrine.

1-Phenyl-3-methyl-5-pyrazolone was obtained by Knorr by the action of phenylhydrazine on ethyl acetoacetate (D.R.P. 26429; *Ber.* 1883, 16. 2597; 1884, 17. 546; 1885, 18. 311, 931, 2256; *Annalen*, 1887, 238. 137).

The compound, which has the formula $C_{10}H_{10}ON_2$, and is soluble in acids and alkalies, was at first taken for a derivative of quinoline; subsequently it was recognised as a pyrazole derivative.

Methyl iodide, in presence of sodium methoxide gives a dimethyl-derivative identical with that obtained by the condensation of phenylhydrazine with dimethylacetoacetic ester.

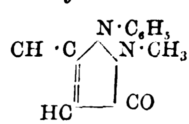
Phenazone, Antipyrine.—In the absence of alkalies, alkyl halides attach themselves to the second nitrogen atom, which thereby becomes quinquevalent. The preparation of antipyrine as originally described consisted in heating equal weights of phenylmethylpyrazolone, methyl iodide and methyl alcohol under pressure to 100°, decolorising the reaction product with sulphurous acid, distilling off the alcohol and separating the base as a heavy oil by the addition of strong caustic soda solution; by crystallisation from ether it was obtained with a melting-point of 113°. It is understood that methyl bromide is used on the manufacturing scale, and Knorr has also obtained antipyrine by the condensation of acetoacetic ester with *symm*-methyl-phenylhydrazine.

Numerous modifications have been made in the synthesis; phenylhydrazine hydrochloride can be used in place of the free base (Michael, *Amer. C.J.* 1892, 14. 517), and acetoacetanilide in place of the ester (Knorr. *Ber.* 1894, 27. 1175).

1-Phenyl-3-methyl-5-ethoxypyrazole when hydrolysed gives phenylmethylpyrazolone, whilst it is converted into antipyrine by methylation and treatment with alkali (D.R.PP. 72824 and 84142).

Reduction of benzeneazo-crotonic ester gives phenylmethylpyrazolone (Bender, *Ber.* 1887, 20. 2749), and numerous variations of these reactions are known. Crotonic acid itself condenses with phenylhydrazine to furnish phenylmethylpyrazolidone (Knorr, *Ber.* 1892, 25. 762), which may be oxidised by ferric chloride to the pyrazolone, but the corresponding dihydroantipyrine cannot be oxidised to antipyrine.

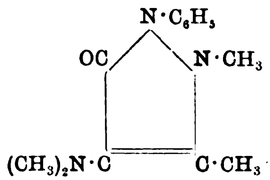
Phenylhydrazine and β-chloro-crotonic acid give a phenylmethylpyrazolone (D.R.P. 64444); on methylation an isoantipyrine (poisonous) is produced, probably



The esters of tetrolic acid also condense to form phenylmethylpyrazolone (Krauth, D.R.P. 77174).

Another way of preparing phenylmethylpyrazolone is from acetone-dicarboxylic acid (von Pechmann, *Annalen*, 1891, 261. 172; D.R.PP. 32245, 32277), the resulting phenylpyrazolone-acetic acid loses carbon dioxide on heating.

Pyramidone.—This compound is 1-phenyl-2, 3-dimethyl-4-dimethylamino-5-pyrazolone.



According to Filehne its physiological action resembles that of antipyrine, but it is three times as powerful, its action develops more slowly and lasts longer.

Antipyrine is converted into its nitroso-derivative which is reduced and the amino-antipyrine isolated as its benzylidene derivative. The latter is decomposed by hydrochloric acid, the benzaldehyde removed by ether and the amino-group subsequently methylated (D.R.PP. 90959, 97011, 97382).

To avoid the formation of quaternary ammonium compounds, Meister, Lucius and Brüning form the diacetic acid of the amino-antipyrine, $C_{11}H_{11}ON_2 \cdot N(CH_2COOH)_2$, and subsequently remove two molecules of carbon dioxide by heating with dilute acids to 130°–140°.

The Société Chimique de l'Avanchet (D.R.P. 203753) achieves the same result by making use of the reaction expressed by the equation

$$C_{11}H_{11}ON_2 \cdot NH_2 + NO \cdot N(CH_3)_2 = N_2 + H_2O + C_{11}H_{11}ON_2 \cdot N(CH_3)_2.$$

Pyramidone may also be obtained from 4-Bromoantipyrine by the action of dimethylamine and methods for stabilising the amino-group during methylation are described by Meister, Lucius and Brüning (D.R.P. 189842) and Scheitlin (D.R.P. 199844).

Modified Alkaloids.

The valuable therapeutic properties of many alkaloids render them indispensable, since in many cases no suitable synthetic substitutes have been prepared. Thus the desirable properties of quinine and morphine are not found fully associated with any artificial drug. Such natural compounds, therefore, remain essential, though they may have drawbacks as well as advantages, and it is a matter for the chemist to make derivatives eliminating the disadvantages whilst preserving the valuable properties.

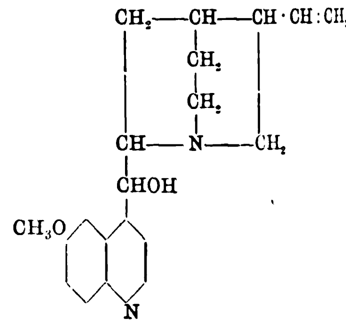
A few examples of modified alkaloids will give an idea of the methods adopted in making constitutional variations.

Quinine Derivatives.

Quinine—$C_{20}H_{24}O_2N_2$—occurs in cinchona bark associated with several other alkaloids, amongst which cinchonine may be specially mentioned. Cuprea bark also contains quinine and an alkaloid cupreine, structurally closely related to quinine and cinchonine.

Cinchonine—$C_{19}H_{22}ON_2$.
Cupreine—$C_{19}H_{21}O(OH)N_2$.
Quinine—$C_{19}H_{21}O(OCH_3)N_2$.

A probable structure for quinine is—



the methoxyl group being replaced by hydroxyl in the case of cupreine and by hydrogen in the case of cinchonine.

The bitter and lasting taste of quinine is a disadvantage, and many attempts have been made to get over the difficulty. One method is to convert quinine into its tannate. This is nearly tasteless in virtue of its very slight solubility. At the same time the sparing solubility involves uncertainty as to the action of the drug, which is not split into its components before reaching the intestine. A more ingenious and effective way is to alter some portion of the quinine molecule so as to give a tasteless product which can get beyond the mouth and subsequently be hydrolysed in the stomach or intestine with regeneration of the alkaloid. The alcoholic hydroxyl group gives an opportunity, and by its esterification several nearly tasteless quinine derivatives have been prepared.

Zimmer and Co. applied for a patent in 1895 (D.R.P. 90848) to protect the conversion of quinine into the chlorocarbonate, the anhydrous base being brought into reaction with phosgene in benzene solution. The following equation is given to explain the reaction:—

$$COCl_2 + 2C_{20}H_{24}O_2N_2 = C_{20}H_{23}ON_2(OCOCl) + C_{20}H_{24}O_2N_2, HCl.$$

No specific action is attributed to the drug: its advantage is simply its tastelessness. Further patents dealing with the reaction and

extending it to other cinchona alkaloids were taken (D.R.PP. 93698, 118122), whilst D.R.P. 105666 varies the reaction so as to give the carbonic ester of quinine.

$$COCl_2 + 4C_{20}H_{24}O_2N_2 = CO(O{\cdot}C_{20}H_{23}ON_2)_2 + 2C_{20}H_{24}O_2N_2, HCl.$$

This product was introduced as *Aristoquinine.* It is practically tasteless, and hydrolyses to quinine and carbonic acid. (See also D.R.PP. 117095, 134307, 134308.)

Probably the greatest improvement in the direction of making a practically tasteless but easily hydrolysed quinine compound is connected with the conversion of quinine into carbalkyloxy-compounds such as "quinine ethyl carbonate" or euquinine (D.R.PP. 91370, 118352, 123748).

Quinine ethyl carbonate is stated by Zimmer to be obtainable by the action of ethyl chlorocarbonate on two molecules of quinine.

$$2C_{20}H_{24}O_2N_2 + ClCO_2C_2H_5 = C_2OH_{24}O_2N_2, HCl + C_{20}H_{23}(OCO_2C_2H_5)CN_2.$$

The liberated hydrochloric acid may also be fixed by caustic soda or pyridine.

Otherwise, the ethyl chlorocarbonate is brought to reaction with a dry quinine salt.

Various methods of covering the hydroxyl group and eliminating the bitter taste have been proposed, such as the formation of quinine urethanes (Zimmer, D.R.P. 109259).

$$C_{20}H_{23}(OH)ON_2 + O : C : N{\cdot}X = C_{20}H_{23}(O{\cdot}CO{\cdot}NHX)ON_2.$$

By heating with aromatic esters, esters of quinine are obtained. Saloquinine, the salicyl ester of the alkaloid, is obtained by heating quinine with salol, phenol being eliminated (D.R.PP. 128116, 129452, 131723, 137207). Auroquine is the *p*-aminobenzoic ester of quinine.

Acetylation may be resorted to (Knoll and Co., D.R.PP. 131595, 200063), whilst "Insipin" is the diquinine ester of diglycollic acid (Boehringer, D.R.P. 237450).

Various reduction products of quinine have been described, obtained by the action of hydrogen in presence of a catalyst (Zimmer, D.R.PP. 234137, 252,136). Hydroquinine is stated to be superior to quinine in its action on trypanosomes.

Morphine Derivatives.

Morphine—$C_{17}H_{19}O_3N$—is one of the chief alkaloids contained in opium. It is associated with papaverine, codeine, thebaine, narcotine, etc. Without going at length into the constitution of these alkaloids, it may be noted that of the three oxygen atoms in morphine, one belongs to an alcoholic, the other to a phenolic hydroxyl, whilst the third atom of oxygen forms a member of a closed ring, which also contains a tertiary nitrogen atom in the form $\rangle$N. CH_3.

Codeine—$C_{17}H_{18}(OCH_3)O_2N$—is morphine methylated on the phenolic hydroxyl. Knoll (D.R.P. 39887) patented the preparation of codeine and ethyl-morphine by boiling morphine in alcoholic solution with alkali and an alkaline methyl or ethyl sulphate. The methylation of morphine may also be effected by the use of diazomethane (D.R.PP. 92789, 95644, 96145), or alkyl sulphates (D.R.P. 102634), phosphates (D.R.P. 107225), nitrates (D.R.P. 108075), and sulphites (D.R.P. 214783).

Dionine is the hydrochloride of ethyl-morphine, and

Peronine (Mering, D.R.P. 91813) the hydrochloride of benzyl-morphine.

Diamorphine (Heroine) is official; it is diacetylmorphine.

"The object in forming these bodies has been to produce a sedative resembling morphine, which will relieve pain without having the depressing action of morphine on the respiratory centre.

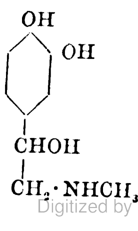
"All three are employed to diminish useless cough and alleviate other forms of peripheral irritation." (Dixon, "A Manual of Pharmacology," 4th Edition, p. 139.)

Apomorphine is official as its hydrochloride—$C_{17}H_{17}O_2N,HCl$; it is obtained by the action of hydrochloric acid on morphine.

Morphosan—$C_{17}H_{19}O_3N(CH_3)Br + H_2O$—is a different type of compound; it has been used as a sedative and hypnotic.

Adrenaline.—Before leaving alkaloidal substances, we may mention adrenaline (epinephrine, suprarenine), a basic substance which is the active principle of the suprarenal gland.

It was first isolated in an impure condition by Abel and Crawford in 1897, and Aldrich (*American Journal of Physiology*, 1901, 5. 457) found that its formula was $C_9H_{13}O_3N$. This was confirmed by Jowett (*Transactions of the Chemical Society*, 1904, 85, 192), who assigned to it the constitution—



This formula was confirmed by Friedmann (*Beitr. chem. Physiol. Path.* 1904, 6. 92; Pauly, *Ber.* 1904, 37. 1387; Stolz, *ibid.* 4149).

Compounds nearly allied to adrenaline in constitution have been synthesised by Barger and Jowett (*Transactions of the Chemical Society*, 1905, 87. 967) and Dakin (*Proceedings of the Royal Society*, B. 76. 491, 498).

An artificial drug, having much the same action as adrenaline, has been introduced by Burroughs and Wellcome under the name of *Ergamine;* a recent technical synthesis of adrenaline may be noted (Nagai, Brit. Pat. 118298).

Organo-metallic Compounds.

Metallic salts of organic acids are largely employed in medicine, frequently with the object of combining the specific actions of the base and acid. But there is a further class of compounds in which metal is directly combined with carbon, and these compounds are frequently of very considerable use.

In considering these substances, it may be easier if we follow the periodic classification of the elements, including certain compounds of non-metallic elements.

Copper.

Copper salts have but limited application, and no compounds are used in which copper is directly attached to carbon.

Silver.

A large number of silver preparations have been introduced, but it is doubtful whether in any of them the silver is in real organic combination, *i.e.* directly attached to carbon. In the greater number, silver or a silver compound is held in colloidal solution. The bactericidal properties of the silver remain unimpaired, but the preparations have not the irritating effect of silver nitrate.

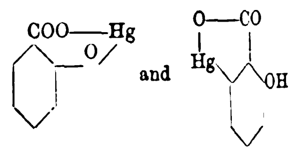
Mercury.

Mercury is an element which readily forms organo-metallic derivatives. Many of these are of considerable value, whilst they have great chemical interest, in that mercury salts directly attack organic compounds, hydrogen being eliminated and the mercury attaching itself directly to carbon.

For a mercury compound to be really useful, it should not precipitate protein substances, and should be capable of being injected subcutaneously or intramuscularly with a minimum of pain; at the same time it should dissolve quickly in water. Colloidal mercury (Hyrgol), the compounds obtained by the action of phenols on mercury nitrate (D.R.P. 48539), and the mercury derivative of formamide (O. Liebreich, 1890), have found but limited application.

Other amides and amino-acids have been used for the preparation of mercury compounds, *e.g.* glycine (v. Mering), succinimide (Vollert), and asparagin (Ludwig).

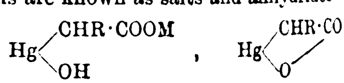
So-called basic mercury salicylate (Hydrargyrum Salicylicum) has found considerable application; of the two formulæ



the latter, with mercury in organic combination, is the more probable. Though it is insoluble in water, it forms soluble salts with the alkaline chlorides.

Easily soluble compounds (*e.g.* Asurol) with amino-aliphatic acids have also been prepared (D.R.PP. 224435, 224864), as well as with various imides of acid function (barbituric and parabanic acids, D.R.P. 227391).

Mercuriated derivatives of the aliphatic acids may be prepared by the action of mercuric oxide on malonic ester, hydrolysis and elimination of carbon dioxide; the resulting mercuriated acids are known as salts and anhydrides



(Schöller and Schrauth, *Ber.* 1908, 41. 2087. D.R.PP. 208634, 213371, 234054).

1. *Afridol.*—Sodium salt of Hydroxymercuric-o-toluic acid.

2. *Hydrargyrol* is a mercury derivative of phenol-*p*-sulphonic acid. *Asterol* is a double compound with ammonium tartrate.

3. *Hermophenyl* (Lumière and Chavrottier) is obtained by digesting an alkaline solution of phenoldisulphonic acid with mercuric oxide.

4. *Phenegol*, *Kresegol* and *Thymegol* are derivatives of o-nitro-phenol and cresol- and thymol-sulphonic acids.

5. It is possible to obtain organic derivatives containing both mercury and iodine; thus *Anogon* is the mercurous salt of 2 : 6-diiodo-phenol-4-sulphonic acid.

Aluminium.

Various salts of aluminium have been introduced as astringents; they are of no particular interest.

Alformin.—Basic aluminium formate.

Alsol.—An acetotartrate.

Alumnol.—Aluminium napthol-sulphonate.

Boral.—Alumina and boric acid dissolved in formic acid.

Cutol.—Alumina with boric and tannic acids.

Salumines.—Salicylates of aluminium.

Sozal.—Aluminium phenol-*p*-sulphonate.

Cerium.

Phenolic compounds react with cerium salts to give cerphenols, cerguaiacol, cernaphthol, etc. According to Schering (D.R.P. 214782) these compounds have a greater disinfectant power than the phenols themselves, and are, at the same time, less toxic.

Phosphorus.

Compounds in which phosphorus is in true organic combination have not found organic medicinal application. On the other hand, the glycero-phosphates, on account of their close relationship to lecithin, have been used extensively. Glycerine is brought into ester combination with phosphoric acid by heating with metaphosphoric acid, metaphosphates or monobasic phosphates.

Arsenic.

The organic compounds of this element are of great importance and interest. Arsenic may be brought into organic combination in a variety of ways.

1. Distillation of arsenious oxide with potassium acetate gives Cadet's fuming liquid, from which Bunsen prepared the cacodyl compounds and cacodylic acid.

2. Tetramethylarsonium iodide and some trimethylarsine are obtained by the action of methyl iodide on sodium arsenide (Cahours and Riche).

3. Arsenious halides react with zinc-alkyls (Hofmann).

4. Arsenious halides react with mercury aryls (Michaelis).

5. Sodium removes halogen from a mixture of arsenious chloride and aryl halide (Michaelis).

6. Aromatic compounds sometimes react with arsenious chloride, hydrogen chloride being eliminated (Michaelis); a corresponding reaction takes place with the sodium derivatives of some ketones (Morgan and Micklethwaite).

7. Arsines can be obtained by the action of Grignard's reagents on arsenious chloride (Pfeiffer).

8. Methyl iodide and sodium arsenite give sodium methyl arsinate (v. Meyer).

9. By alternate reduction and methylation this reaction may be made to furnish cacodyl compounds and trimethylarsine oxide (Auger).

10. Arsenic acid reacts with amines and phenols, giving amino- and hydroxy-aryl arsinic acids (Béchamp; Ehrlich and Bertheim). These may be reduced to arsenoso- and arseno-compounds.

11. Diazonium salts react with arsenites to give aryl-arsinic acids (Bart.).

12. Arsenious chloride adds on at the triple linkage of acetylenic hydrocarbons (Bayer and Co.).

Cacodylic acid—$(CH_3)_2AsO\cdot OH$—is usually administered in the form of the sodium, magnesium, or iron salt.

Arrhenal—$CH_3\cdot AsO(ONa)_2 + 5H_2O$—is the disodium salt of methylarsinic acid.

Of late years chief interest has centred round the aromatic compounds of arsenic on account of their pronounced action in protozoal diseases.

Atoxyl, sodium aminophenylarsinate, was the first of these substances to be introduced therapeutically. Béchamp (*Compt. rend.* 1863, 56. i. 1172) heated aniline arsenate to 190°-200°, obtaining a substance which he took for an anilide of arsenic acid. Using our present atomic weights the reaction would be represented by

$$C_6H_5NH_2, H_3AsO_4 = H_2O + C_6H_5NH\cdot AsO(OH)_2.$$

It was assumed that the substance known as "Atoxyl" was such an anilide. In 1907 it was chemically examined, found to contain sodium (Fourneau, *J. Pharm. Chim.* 1907, vi. 25. 332), and, thanks to Ehrlich and Bertheim (*Ber.* 1907, 40. 3292), shown not to be an anilide but to contain a free amino-group. Atoxyl is, in fact, the monosodium salt of *p*-aminophenylarsinic acid. This was clear since the compound could be diazotised without removing the arsenic, whilst by replacing the arsinic group by iodine, *p*-iodoaniline was formed. Several salts and derivatives were introduced as antisyphilitics.

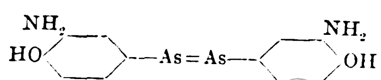
Argatoxyl.—Silver salt.

Asiphyl.—Mercuric salt.

Arsacetin.—$CH_3CONHC_6H_4AsO(OH)_2$.

Hectine.—$C_6H_5SO_2NHC_6H_4AsO(OH)_2$.

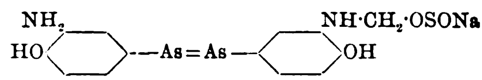
Salvarsan.—The most important synthesis amongst the aromatic arsenic compounds is that of salvarsan—



Hydroxyphenylarsinic acid is obtained either by the diazotisation of atoxyl or by the direct action of arsenic acid or phenol. The compound is then nitrated to *m*-nitro-*p*-hydroxyphenylarsinic acid, and the nitro- and arsinic-groups reduced in turn to amino- and arseno-groups.

Sodium hyposulphite is employed as reducing agent, and the sulphur found in commercial salvarsan appears to be in actual combination, possibly as a sulphamo-group (Fargher and Pyman, *Trans. Chem. Soc.*, 1920, 117, 370).

Neosalvarsan has the formula—



Its ready solubility in water is an advantage over salvarsan.

Ehrlich and Karrer (*Ber.* 1915, 48. 1634) have made additive compounds of salvarsan with several metallic salts. The compound with $1\,CuCl_2$ is stated to be very active against trypanosomes, and the curative dose is only 15 per cent. of the lethal dose.

The constitution of silver salvarsan and allied substances has been dealt with recently by Binz, Bauer and Hallstein. (*Ber.*, 1920, 53, [B], 416.)

Danysz (British Pat. 104496, 104497) finds that many of the compounds of salvarsan with metals are unstable and easily decomposed by alkalies. By making antimonyl derivatives compounds may be obtained containing silver, mercury and other metals; these are said to be more soluble, more active, less toxic, and to be stable in alkaline solution.

In this connection it may be mentioned that von Heyden (D.R.P. 296940) obtains organic compounds containing antimony by diazotising amino-derivatives of arsenic compounds and allowing the diazonium salts to react with antimonites.

Antimony.

But few compounds containing antimony directly attached to carbon have found medicinal application.

Sulphoform is a trade name for triphenylstibine sulphide $(C_6H_5)_3Sb : S$; it has been used in dermatological practice.

Bismuth.

The compounds of this metal have a very favourable action on wounds, and some of them may be used as iodoform substitutes. The internal uses of bismuth are also well known.

Many artificial preparations have been introduced into medicine in which the bismuth is present as positive radical of a salt, not in direct combination with carbon.

Airol, Airoform, Airogen— $C_6H_2(OH)_3COOBiI(OH)$.

Bismal.—Methylene-digallate.

Dermatol.—Basic gallate.

Eudoxin.—Basic salt of tetraiodophenolphthalein.

Gastrosan.—Basic salicylate.

Hetoform.—Basic cinnamate.

Iodylin.—Iodosalicylate.

Neoform.—Basic triiodophenolate.

Orphol.—Basic betanaphtholate.

Phenolate.—Basic.

Xeroform.—Derivative of tribromophenol.

Sulphur.

The presence of this element, together with the unsaturated nature of the compounds, seems to be responsible for the properties of the various ichthyol preparations made from the bituminous shales of the Tyrol.

Iron.

This element does not form proper organo-metallic derivatives. The various preparations containing iron and protein cannot strictly be looked on as synthetic compounds.

I have great pleasure in acknowledging the kind help afforded by the following firms, who have lent specimens in illustration of these lectures:—

Messrs. Boake, Roberts & Co., Ltd.
,, British Drug Houses, Ltd.
,, British Dyestuffs Corporation (Huddersfield), Ltd.
,, Burgoyne, Burbidges & Co., Ltd.
,, Burroughs Wellcome & Co.
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PAPER-MAKING MATERIALS IN THE PHILIPPINES.

The Philippine Islands produce an abundance of fibres and other raw materials for the manufacture of paper pulp on a commercial scale, but at present none of these is being utilised for this purpose. So far as is known, no paper has ever been made in the Philippines except for experimental purposes. The country also contains plenty of the raw materials required for the manufacture of the chemicals used in paper pulp making, but none of these chemicals is now being produced locally.

More than a decade ago, Mr. G. F. Richmond, for several years attached to the chemical laboratory of the Philippine Bureau of Science, made a very careful survey of the materials available in the Philippines for the manufacture of paper pulp, but, according to a report by the U.S. correspondent at Manila, no practical use has yet been made in the islands of these valuable data.

The experiments made by the Bureau of Science were undertaken with the object of determining the commercial availability, for paper-making, of the fibres from members of the plantain family, such as abaca (manila hemp), banana, and plantain; of maguey (*Agave cantula*); of certain palms; of bamboo; of grasses; of certain woods; and of other less important plants.

Bamboo.—Of all the materials for the manufacture of paper found in the Philippines, the bamboos are the most important, considered from every standpoint. Not only is the paper made from bamboo of excellent quality, but a constant, adequate, and accessible supply of this material could be made available for a paper or pulp factory more readily than could such a supply of any other material. Its rapidity of growth is an important item among the various qualities that render bamboo valuable as a paper-making material. Experiments were made with the two most important and widely-distributed bamboos. These are the common, thick-walled variety (*Bambusa blumeana*), and the thin-walled, dwarf bamboo, also known as caña bojo, of the genus *Schizostachyum*.

The thick-walled variety is that commonly employed for building purposes throughout the islands. It is planted as a crop along the river bottoms of the Pampangan plain, on Luzon, and in other sections of the Philippines as well. Propagated from cuttings, the plants are set out in rows from sixty to ninety centimetres apart. Marketable culms are produced in from one to two years.

The caña bojo, or dwarf bamboo, is that employed throughout the Philippines for the manufacture of woven products used for furnishing the interiors of nipa houses and for other purposes, such as the *sauale*, *quisame*, and *amatong*. The caña bojo is found almost entirely within the forested regions of the country and is a veritable forest pest. It is never cultivated, but is cut without restraint in the forest regions to prevent its deleterious effect on forest growth.

In the Province of Bataan there are two contiguous areas of caña bojo, one of them containing 1,200 hectares (hectare = 2·47 acres), 800 hectares of which are covered with a dense stand of caña bojo. The other area includes about 650 hectares, of which over 40 per cent. is covered with this variety of bamboo. Small areas of caña bojo are found in the same province along the Bamban, Buasao, Pinulot and Bacan rivers, in the basin of the Colo River, and in the basin of the Mababo or Balsic River. Some of these areas contain a higher percentage of timber trees than do others, and are, consequently, less thickly studded with bamboo. In an average stand of this variety of bamboo there are about 9,000 culms to the hectare. An ordinary green cane weighs 7·2 kilos, and an air-dried cane, without the nodes, weighs 3·75 kilos. A hectare would, therefore, produce about 33·75 metric tons of dried material. Mr. Richmond calculated from his experiments that two metric tons of air-dried material would produce about one short ton of pulp. The yield of pulp would consequently be approximately seventeen tons to the hectare, or nearly eight tons to the acre.

The experiments made by Mr. Richmond developed the following important facts in respect to bamboo as a paper-making material:—

1. The dwarf bamboo (caña bojo) is better than the variety used for building purposes, in that it yields more unbleached pulp and requires less of the bleaching agent to give the best results. The structural bamboo requires from 20 to 25 per cent. of bleach to give but poor results, but a satisfactory white is obtained from dwarf bamboo with from 10 to 20 per cent. of bleach. This compares well with the results obtained from straws of various kinds.

2. A well-digested pulp is obtained from bamboo by the use of from 10 to 20 per cent. of caustic soda, calculated on the gross weight of the stems.

3. The time required for digestion, the pressure and the temperature employed are materially less than those required in making pulp from soft woods by the same process. In fact, in these particulars, bamboo compares favourably with straw and similar materials.

4. Both the sulphite and soda processes may be employed in working up caña bojo. By the former process, fully 50 per cent. of unbleached pulp may be obtained, and that, with the use of much less sulphur than is necessary for the making of wood pulp. By the latter process 43 to 45 per cent. of air-dry, unbleached soda-pulp is obtained. The use of caustic soda is recommended for bamboo because of certain difficulties to be overcome in the use of the sulphite process. The results described were obtained by the use of caustic soda under the following conditions: (*a*) Upright cylindrical stationary digesters; (*b*) direct live-steam heat; (*c*) 15 to 20 per cent. of 76 per cent. caustic soda, calculated on the air-dry weight of the raw material; (*d*) a duration of cooking of from four to six hours; (*e*) a maximum temperature 160° C. (320° F.) corresponding to a steam pressure of 45 kilos.

5. Pulp obtained by the sulphite process is not light enough in colour to be mixed with

mechanical wood pulp in the manufacture of news-print paper. It is entirely suited in point of colour for use as a wrapping paper. But it is too valuable, by reason of its fibre, to be used for wrapping paper or for the making of newspaper stock. The strength of bamboo fibre makes it specially adapted to the manufacture of book paper and certain grades of writing and lithographic papers. For these purposes it may be used alone or mixed with rag or sulphite wood pulp.

6. If the bamboo pulp is to be used in the making of book and lithographic papers, the soda process should be employed in its manufacture, because bulk, softness and opacity are the chief features of soda pulp. This pulp bleaches to an excellent white with from 12 to 15 per cent. of bleaching powder. The resulting sheet is more bulky than that from wood pulp and possesses a strong fibre 2·5 to 3 millimetres in length—longer and narrower than spruce fibres—and a good felting capacity.

Abaca or Manila Hemp.—The Philippine Archipelago is the home of abaca (manila hemp), the source of all materials from which the genuine Manila hemp paper is made. The plant (*Musa textilis*) is a species of wild banana, of which there are several found in the Philippines. The fibre from this plant is the world's premier cordage material and comprises the chief article of export of the Philippine Islands.

Abaca waste, available for paper-making, is of two kinds, namely, that made up of old worn-out rope, gunny sacks, waste thread, and binder twine made from the fibre; and the true abaca waste, *i.e.*, the fibre that is missed in the stripping of abaca or extracting the fibre from the stalk of the plant. There is very little of the former to be had in the Islands. When abaca waste is mentioned in the Philippines, the term signifies that portion of the fibre that is missed or thrown aside with the stalk pulp at the time of, and in the process of stripping the fibre or extracting it from the plant, either in the hills or on the plantations where it is grown.

Abaca, the fibre extracted from the plant of the same name, is taken from the petioles or sheath-like leaf stalks, which, wrapped one about another, form the stem or trunk of the plant. The stripping process consists of separating the fibre from the cellular matter of the petiole.

From this process two kinds of waste material are obtained, both of which are of value in paper-making. One of these is called fibrous waste, and the other semi-fibrous waste. The former is made up of the broken, tangled, or lost but clean fibres mixed with strips or bands of fibre aggregates from which the cellular and incrusting matter has not been entirely removed. The fibre contained in this waste has all the qualities of the fibre that is recovered by the stripper and subsequently employed in the manufacture of cordage. It is therefore identical with the fibre contained in rope waste, well known among manufacturers of paper. There is this difference, however; this fibre is fresh and has not suffered the deterioration of age.

The semi-fibrous waste resulting from the process of stripping abaca is due chiefly to the method by which the stalk of the plant is made ready for the stripping process. The plant is prepared for hand stripping by cutting off a portion of each end of the stalk to facilitate the removal of the petioles. Several of the outer of these are usually discarded on account of being bruised and discoloured. The fibre which is recovered as the abaca of commerce is contained chiefly in the outer surface of the petiole. The inner surface of the petiole and the portion between the two surfaces are made up, for the most part, of cellular matter, although they also contain much fibre of a lower tensile strength than that contained in the outer surface.

After the petiole has been removed from the plant stalk, preparatory to stripping by the hand process, ribbon-like strips are peeled from the entire length of its outer surface. Only these thin, fibrous ribbons are submitted to the hand-stripping process. All the remainder of the petiole is discarded. As already pointed out, this discarded portion, while containing chiefly watery, cellular matter, also has much fibre that is valuable, though never recovered by the hand process of stripping. This cellular portion of the petiole, the discarded outer petioles and the cut ends of the stripped petioles make up the semi-fibrous waste of abaca.

The habitat of abaca is in southern Luzon: the Provinces of La Laguna, Cavite, Batangas, Albay, Ambos Camarines, and Sorsogon; Samar and Leyte and southern Mindanao, chiefly. A mill situated anywhere in the islands would require a more or less considerable haul for most of its supply of abaca waste. It would also have to solve the problem of collecting the waste in the various regions where it is produced. Undoubtedly this would be an easy matter. Once abaca growers knew that there was a market for the waste at a price to leave a reasonable margin of profit over the cost of baling and collecting, the waste would be taken care of as systematically as is now the case with cordage fibre. In fact, a considerable amount of this material has been collected and exported from the Philippines at different times.

The semi-fibrous abaca waste, owing to the length of time, the pressure and the strength of caustic soda required to remove the cellulose matter, cannot be used profitably in the manufacture of the better grades of paper. But this material might readily be manufactured into wrapping paper of the sort in which strength and cheapness are of more importance than colour, by the process employed in working up

jute—that is, by the use of lime, cooking under pressure, and partial bleaching.

Grasses.—Grasses of several varieties have long been in use for the manufacture of paper stock. Perhaps the most widely known of these is the esparto grass (*Stipa tenacissima*), for many years an article of commerce in the Mediterranean countries. This grass has been employed in some of the mills of Europe for many years. In India, the Bhabar grass (*Ischaemum angustifolium*), which yields a paper but little inferior to that of esparto, is very generally in use. The Munj grass (*Saccharum sara*) and several other grasses of the same species are constantly used. The paper industry of India is founded principally on these grasses and has become very extensive.

Mr. Richmond experimented with two Philippine grasses, cogon (*Imperata exaltata Brong*), and Talahib (*Saccharum spontaneum*), and found each to be an important source of paper stock. Cogon grass grows from two to four feet in height, and is found in even stands on open lands, foot hills, and low mountains in almost every part of the Philippines. It is broad-leaved, gregarious, and thrives with but little moisture on almost any sort of land. In many sections of the Islands, where nipa is not to be had, the natives rely on cogon grass roofing and siding for their houses.

Cogon grass is found in abundance in the central plain of Luzon on most of the open land. In the Province of Tarlac, between Capas and Concepcion, there is a good stand of cogon grass covering a level area of abandoned rice and sugar land. The grass on this area is usually of good stand and quality. Throughout Tarlac Province and, to a less extent, in the adjoining provinces, there are large areas of open land covered with cogon grass of good quality. Cogon grass is also abundant in the Visayan Islands.

Cogon grass is not jointed. This quality is regarded as of great advantage in the matter of making paper pulp. Its yield is from 5 to 10 per cent. more than that of cereal straws, and it is more easily pulped with a smaller proportion of caustic soda. It has the further advantage over cereal straws that it can be harvested just before it is ripe, a period when it gives the best results. Cogon is easily prepared for digestion, and requires no preliminary cutting down after being dried, hand-picked, or machine cleaned.

Talahib (*Saccharum spontaneum*) is a coarse jointed grass growing from six to ten feet tall. It is gregarious, and springs in tufts from stout underground root stalks. Talahib is often confounded with cogon grass. It is very different from the latter, however, in both its appearance and habits of growth. Talahib thrives best in low, moist land and flourishes in river valleys and areas subject to annual floods.

This grass generally occurs with or near cogon grass, growing vigorously in the wet places where cogon does not do so well, and being of a poor variety on the uplands where cogon thrives well. It is difficult to get rid of. Cutting and burning has but little effect on it other than to increase its yield and quality. Talahib is related to the *Saccharum sara* (the Munj grass of India) and *Saccharum officinarum* (the sugar cane of tropical countries).

An experiment carried out by Mr. Richmond with a small quantity of talahib, fully matured with entire stems and leaves, gave as result a percentage of 53·9 of cellulose.

Bananas and Plantains.—Plantains (*Musa paradisiaca*) and bananas (*Musa sapientum*) contain much fibre that might be utilised in the manufacture of paper stock. These plants abound almost everywhere in the Philippines. Probably close to 100,000 acres are planted to them. The fibre from them has not the tensile strength of abaca, but this is considered by Mr. Richmond an advantage when the fibre is to be employed in the manufacture of paper pulp. Nearly 20,000,000 bunches of fruit are gathered yearly in the Islands from these plants, and there are, therefore, a like number of full-grown stalks which annually go to waste, since practically no use is now made of them. The figures do not include the wild non-edible plantains, which are common throughout the Philippines and which might be utilised in the making of paper stock.

The chemical investigation of plantain fibre carried out at the Bureau of Science showed a percentage of 68·21 of cellulose. There appears to be no good reason why a plantation of bananas might not yield a profitable revenue from its fruit, and at the same time supply a pulp mill with the stalks discarded when the fruit is harvested. At the present time no bananas are exported from the Philippines, nor is the domestic market as well supplied as it should be, considering how valuable the fruit is as an article of diet.

Maguey Waste.—Maguey (*Agave cantula*) and sisal are being extensively planted in several sections of the Philippines. These plants yield a fibre that is well known to the cordage world. This fibre is extracted by retting at present, but a movement is on foot to revolutionise the methods of recovering it by the introduction of machines. When maguey and sisal fibre is extracted by machinery there is a considerable quantity of waste that is comparable to abaca waste. The maguey, owing to the nature of the leaf of the plant, is considerably more bulky than abaca waste.

Other Materials.—Bowstring hemp (*Sanseveria zeylanica*) is found in many parts of the Archipelago. It is not, however, of commercial importance. It has possibilities and might be cultivated for its fibre, which is not unlike that of maguey.

Coconut coir (husk fibre) might be produced in abundance in all the coconut regions. At the present time this by-product of the coconut industry is almost entirely neglected. It might be utilised very profitably in the manufacture of paper.

The leafstalks of the nipa palm contain valuable paper substance. At present little or no use is made of these, though a vast amount of the nipa leaf is used in almost every section of the islands for thatch and siding for houses.

The buri palm is widely used in the manufacture of hats and other handicraft products, and yields an immense amount of waste in the process of extracting the material utilised for these purposes. No small part of this waste might be employed in the making of paper stock.

The milling waste of certain soft Philippine woods is known to be valuable as a source of paper stock. Mr. Richmond made successful experiments with lauan, kupang, and similar varieties.

It is not conceivable that any of the minor sources of paper pulp mentioned above would alone yield enough material to keep a mill in operation, but, nevertheless, they are not altogether negligible at a time when the world appears to be facing a shortage of such substances.

Raw Materials for Paper-Making Chemicals.—It is the opinion of the Director of the Bureau of Science that caustic soda, sodium sulphite and the bleaching powder required in the manufacture of paper could be manufactured in the Philippines if there were a demand for them. At present all such chemicals are imported.

GENERAL NOTES.

BRITISH SHIP-REPAIRING INDUSTRY. — The Government were asked in the House of Commons on August 16th whether much of our ship-repairing work is going to Antwerp and Rotterdam. The Parliamentary Secretary to the Ministry of Shipping admitted that there is a considerable slackening in the repairing industry in this country, causing unemployment, and that there is also a tendency for some of the work to go to Continental ports, "where, it is alleged, costs are lower."

THE INSTITUTE OF METALS.—By invitation of the Mayor and Corporation of Barrow-in-Furness the autumn meeting of the Institute of Metals will be held at that place on September 15th and 16th. Amongst the papers to be submitted are the following: "The Allotropy of Zinc," by Miss Kathleen E. Bingham, B.Sc.; "Crystal Growth and Recrystallization in Metals," by Professor H. C. H. Carpenter, F.R.S., and Miss Constance F. Elam; "The Constitution of the Alloys of Aluminium and Magnesium," by D. Hanson, M.Sc., and Miss Marie L. V. Gayler, B.Sc., and "Notes on Brass Foundry Practice at Messrs. Vickers, Limited, Barrow-in-Furness," by H. B. Weeks, F.I.C. The programme includes works visits to Messrs. Vickers, the Barrow Hematite Steel Works, the Furness Railway, the Barrow Paper Mills, the Hodbarrow Mines, the Millom and Askam Hematite Iron Works, and the North Lonsdale Iron Works.

PEARL FISHERY OF ECUADOR.—The production of the pearl fisheries off the coast of Manabi—between the ports of Manta and Machalilla—for the fishing season from March to October, 1919, was valued at 25,052 sucres (about £2,500). The United States Consul-General in Ecuador states that during the month of October, 6,508 pounds of pearl shell were shipped out of Manta. Of this amount France received 2,231 pounds, Italy 1,903 pounds, Panama 1,583 pounds, and the United States 791 pounds. France also received 12 pounds of fine pearls.

SCARCITY OF MANGANESE SUPPLIES.—The serious scarcity of the supplies in this country of ferro-manganese ore, an article so needful in the manufacture of steel, has formed the subject of questions in the House of Commons. *Inter alia*, complaint was made of large quantities in India passing into alien, and ultimately into late enemy hands. The President of the Board of Trade stated that action had been taken to improve transport conditions in India, which had been restricting exports, and the imports into the United Kingdom had shown a steady improvement in the last three months. Another point raised was the shortage of railway trucks for conveying the ore to Indian sea-ports. The Secretary of State for India, Mr. Montagu, said he had been in correspondence with the Government of India on this subject for a considerable time, and had asked them to take all possible steps for facilitating transport. It appeared that on July 10th there were stocks of 74,374 tons of the ore at Calcutta, and on July 30th of 9,000 tons at Bombay. Provision had been made for the carriage of 500 tons daily to Bombay. Mr. Montagu said he is aware that both the United States and Japanese steel trades have agencies in India for buying ferro-manganese ore.

PAPER FROM BRITISH COLUMBIA.—British Columbia is now producing 645 tons of paper daily, or about 7,000,000 tons annually—eleven years ago the province was not producing any at all. The progress made in the last eleven years is being maintained, so that during the next few years a considerable increase in the pulp and paper industry of the province is anticipated. British Columbia, according to the *Empire Mail*, produces 14 per cent. of the pulp and paper manufactured in Canada — the second largest paper-producing country in the world — at the present time, being the third largest producing province. Quebec produces 24,000,000 tons and Ontario 21,000,000 tons annually.

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FRIDAY, AUGUST 27, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE ARCHITECTURE AND DECORATION OF ROBERT ADAM AND SIR JOHN SOANE, R.A. (1758–1837).

By ARTHUR T. BOLTON, F.S.A., F.R.I.B.A.,

Curator of Sir John Soane's Museum.

Lecture I.—Delivered May 3rd, 1920.

The opening date of the period which has been taken as the subject of these Cantor Lectures is that of Robert Adam's return from his memorable grand tour, which extended from the summer of 1754 to January, 1758.

The closing date is that of the death (January 20th, 1837) of Sir John Soane, who was born in 1753 and came to London in 1768, the year of the launching of the famous Adelphi enterprise.

Any such selection of dates is, of course, purely arbitrary as one period blends into another, the seed of any change of style has long been germinating, and while all can mark the new growth when it has shot up, few can detect the transitional stages of its development. From the time of the introduction of pure Italian architecture into England by Inigo Jones, in the reigns of James and Charles I., a tolerably regular line of development had been pursued, in spite of the gap caused by the Civil War.

The work of that great architect was the object of the enthusiastic regard of the school of Burlington and Kent. James Gibbs, the immediate leader before Robert Adam, had died in 1754. He was very fairly characterised by Walpole, who said that "Gibbs' merit was fidelity to rule, his defect a want of grace."

The work, therefore, of the period of the two first Georges had been a solid and consistent whole, which it now became the mission of Robert Adam, as a revolutionary artist, to break up and transform. The opening of a new reign in 1760 was of itself a favouring circumstance, and in ten years from that date imitation of Adam work had become general. The commencement of the long ministry of Lord North (1770–1782) marked the close of the troubled period of the transition from the Early to the Late Georgian, and the year 1775, that of the mid-point of Robert Adam's career in London (1758–1792), coincides with the high-water mark of that epoch of prosperity and magnificence. Everybody knows how the American and other wars clouded over the fair prospects. In 1780 occurred the Gordon Riots, in 1782 the Ministry collapsed, and a real recovery was only commencing when the death of Robert Adam took place (March, 1792), almost simultaneously with that of Sir Joshua Reynolds.

In 1793 the Revolutionary Wars began which were almost continuous up to 1815. By the time that peace was re-established after Waterloo a new generation had sprung up, to whom Robert Adam was merely a name, almost a legend, and one grown so distorted that in the current view the Adams had been little better than speculative builders.

Adam work was freely destroyed for the next half century during the ascendancy of the Greek and Gothic Revivals, and it has been the work of this generation to re-establish its fame.

There is a closer link than is generally supposed between the work of Soane and Adam. By reason of his marked personality and long life, Sir John Soane came to be respected and even venerated as the veteran heir of the age before the great wars of the Revolution.

As gold medallist of the Royal Academy (1776) he had been introduced to George III. by Sir William Chambers himself. He was the pupil of George Dance, R.A., and had been an assistant in the office of Henry Holland, jun., and could claim to have been the friend of Robert Adam, James Stuart, and James Wyatt,

who had been the leaders of that remarkable epoch.

Soane as an artist, moreover, was an outcome of Robert Adam's revolutionary mission, belonging more to the Adam and Dance group than to the more orthodox school of Chambers, Taylor, and Paine.

The fundamental idea of Robert Adam that lay at the root of his revolution was the thesis "that the domestic architecture of the Greeks and Romans was entirely distinct from that of their temples." This proposition, which may, perhaps, be regarded as merely a commonplace to-day, called in question the validity of the system of the orders which had been the subject of so much study since men had first turned to the remains of Roman antiquity as a new basis for building, in the earliest days of the Renaissance.

Palladio had systematised the use of the orders, and the universal admiration for his building achievements at Vicenza and Venice had carried his style throughout Europe. His "Architettura" (1570) had been Inigo Jones's handbook in Italy, and the Anglo-Palladian School was fortified by more than a century of successful practice in England.

Robert Adam's earliest work, after his return in 1758 from Italy, is leavened by this tradition, and there has always been a body of opposition to his revolutionary theories and their application in architecture.

Soane accepted Adam's basis, but modified it by the adoption of those Greek ideas and details against which Sir William Chambers had thundered in vain. The Bank of England, to which Soane had been appointed architect in 1788, was the field in which from 1794 onwards this later revolution of Soane's was manifested. The opposition was intense; the feelings of the remnant of the old school were outraged by the young architect's substitution of such unorthodox work, in place of the sound tradition of the school of St. Martin's-in-the-Fields.

After the great war the older school was practically extinct. The Greek and Gothic revivals were in possession of the field, until, in the last years of Soane's life, a new chapter was commenced by the introduction of the Florentine and Roman, Astylar manner, introduced by Sir Charles Barry, R.A. Sir John Soane, R.A., who had started under the influence of Robert Adam, showed in his last work, the new State Paper Office (1829–33), an evident appreciation of this fresh departure.

As all are aware, Robert Adam was the second of four sons of William Adam, sen., an architect of large practice in Scotland up to the time of his death in 1748. John, the eldest of these sons, passed his life in Edinburgh and on his estate at Blair Adam. Robert, the second son, born in 1728, was educated from the age of fifteen at Edinburgh University. James, the third son, born 1730 (?) was also entered there, but under the Greek in place of the Latin professor. Of William, the youngest of the group, very little is known; he seems to have been the business agent of the London practice of Robert and James. As the survivor of the group, living until 1822, he deserves remembrance because it is through his care that the priceless collection of Adam drawings in the Soane Museum has survived.

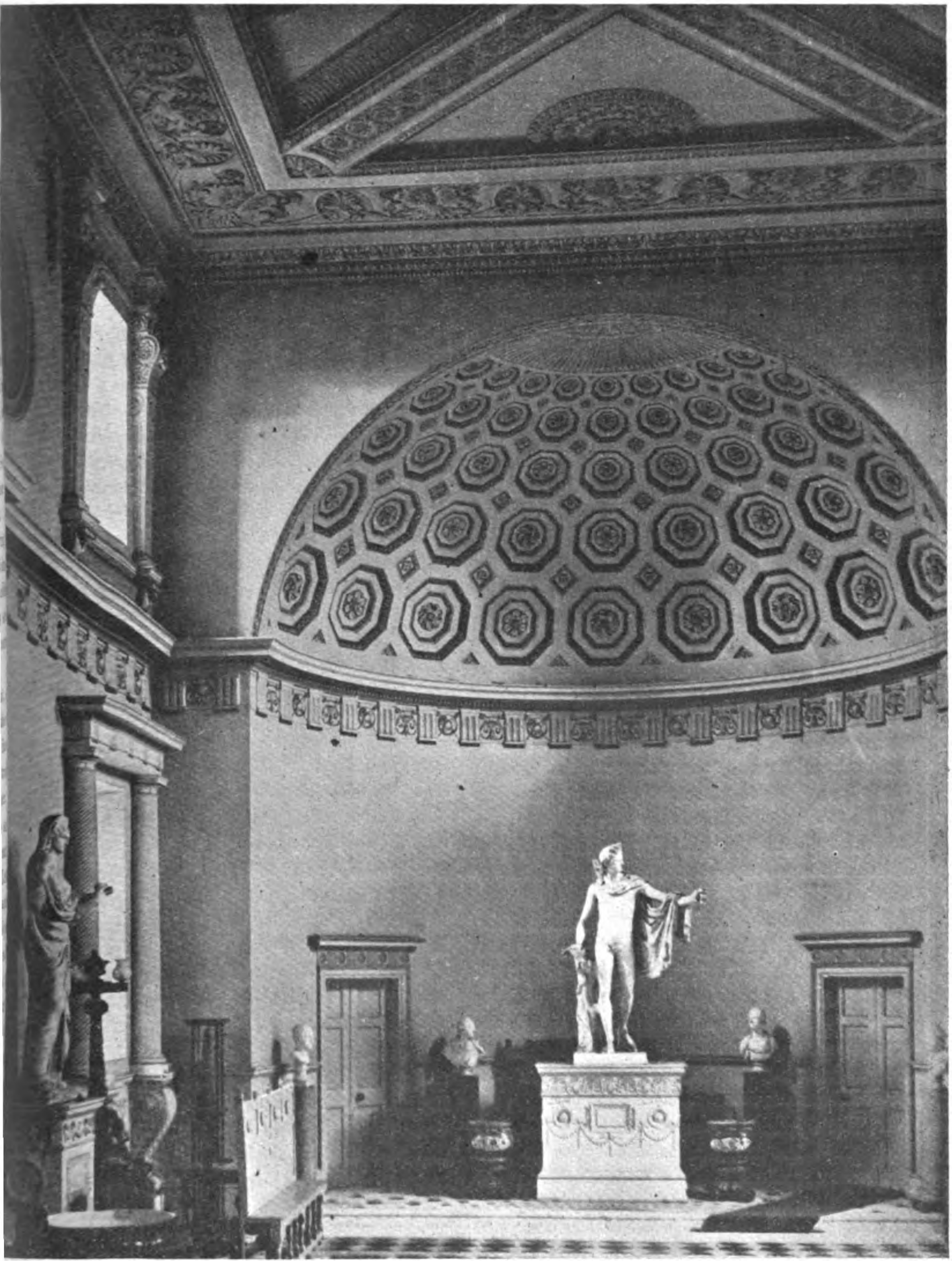
As was stated at the outset Robert returned from his memorable grand tour of nearly four years' duration in January, 1758, and the remainder of his life was passed in London, varied by repeated journeys to Scotland and over all England, in connection with his extensive practice as an architect.

James may be regarded as having been chief of the staff to Robert, while John's position seems to have been that of the eldest brother, to whom a certain deference was shown, as by the inclusion of his name in the contracts, etc., of the Adam Brothers.

There is nothing to show that, apart from the genius of Robert, any one of the other three sons of William Adam, sen., would have achieved anything above the sound and traditional, if heavy and dull, work of their father.

As is well known James made an extended tour from 1760 to 1763 in the early days of Robert's commencing practice in London. He collected pictures, antiques, books and drawings abroad, and directed various studies by draughtsmen and others, as though intending some important work. The architectural results of his tour were, however, unimportant in comparison with that of Robert's earlier tour.

At the same time too much importance has been attached to Robert Adam's highly successful book of 1764 on Diocletian's Palace at Spalato, which he had studied on the spot in 1757. The value of this study was that it enlarged his idea of ancient domestic architecture, and confirmed the view that he had already taken as to the essential difference between the temple architecture of the Greeks and Romans and that of their private houses. The allegation that the Adam style derives from this late Roman work on the coast of the Adriatic is a pure myth, as



SYON HOUSE. THE HALL.

anyone who looks at the book with attention will soon discover. Robert Adam's studies abroad were pursued in a very catholic spirit, and the work of the Early Renaissance, of the Romanesque, and even the Mediæval ages, was not without its effect upon his mind.

As the son of an architect and one who had already certainly taken part in actual work, Robert set out on his grand tour with an exceptional equipment, and on his return he had the ability, knowledge, and fortune, that enabled him to undertake at the outset of his career in London, work of very considerable importance. He seems, therefore, to have escaped the long and trying period of unemployment that is the usual fate of the beginner in architecture.

Before dealing in some detail with a selection from the innumerable works of the Brothers Adam, from 1758 to the close of the century, it will be as well to consider the character and direction of the movement initiated by Robert, because it will be evident that the Adam revolution in style was not merely one of internal architecture and decoration.

No such separation is, in fact, possible, and it was soon evident that his attack on the validity of the order system in use internally could not fail to lessen its importance externally as well. Broadly speaking, the mission of Adam was a recall to the principle that in any treatment of the surface of a building, whether external or internal, the value of the relative planes may be a primary consideration. As applied to street architecture in particular, this is a principle of the greatest value, and it is not limited to any one phase of architectural style. The Adelphi, in its pristine condition, showed a masterly consideration of the problem of low relief; the rigid plainness of the background was a necessary condition of the successful distribution of the ornament in vertical pilaster strips. There was a balance of effect, which has been upset by the subsequent application of details, uncalled for, and destructive of the original breadth of effect.

Robert Adam very soon treated the orders with the same freedom externally as he had claimed internally. He asserts that the architect possessed of any degree of mastery can, and should, vary the received proportions and features of the orders. He thus freed himself of the hampering effect of deep entablatures, composed of the full architrave, frieze, and cornice, as strictly regulated by the width and height of the pilaster or column.

By decorating a plain faced architrave he dispensed with the frieze, and regulated the depth of his cornice by a consideration of its relative value to the tall and wide spaced column, or pilaster, which lent itself to his conception of elegance and decorative effect for domestic buildings. In this way he evolved the façade of an Adam character, which has become a recognised feature of our London streets. He accepted gladly the London stock brick and, whether in stone or stucco, he gave a note of contrasted effect by a sparing but always judicious use of classically derived features.

In a general consideration of the Orders he admits only three—Doric, Ionic, and Corinthian—and he sees that they are each of them representative of a different expression. Proceeding further he discriminates against the current Early Georgian use of the Corinthian with unfluted shafts, arguing with much subtlety that there are relative degrees of enrichment to be observed, and, therefore, where this could not be afforded, a simpler order must be adopted.

Contrary to the general opinion Robert Adam had a special feeling for the Doric order, which he used in his earliest days with remarkable success. The mausoleum at Bowood, as well as the Admiralty screen, may be cited as masterpieces of this application. Similar success attended his employment of the Doric in the various halls of his houses from Syon onwards; and, in his latest great work, the Edinburgh University, the great entrance is a magnificent example of the same style on a grander scale.

It is a curious fact that whereas that pillar of orthodoxy, Sir William Chambers, R.A., was mainly responsible for the Chinese mania, having at Kew Gardens practised an eclecticism of the wildest character, Robert Adam, on the other hand, recalled the taste of his age to the veritable antique.

Current domestic work, when he arrived on the scene, was split into three main currents—Italian, French, and Chinese. The Italian, through Burlington and Kent, had acquired a late Venetian character, work of the type that may be seen in the decorations of the Villa Rotunda, which are commonly regarded as of a date subsequent to Palladio's death. The Villa Maser, where Burlington acquired Palladio's drawings, was frescoed by Paolo Veronese, and the stucco work was by that architect's favourite *stuccatore*, Vittoria. Here, and in the church adjoining, the character of

the decoration is semi-barroque, such as in fact appears to have been intended by Wren himself in St. Paul's, if the well-known engraving of the interior section of the Cathedral is reliable evidence.

French work had only recently been fully exemplified in the interiors of Chesterfield House (1749), where the gilded rococo *salons* still remain, as evidence of the Earl's thesis that a house should be Italian outside and French within.

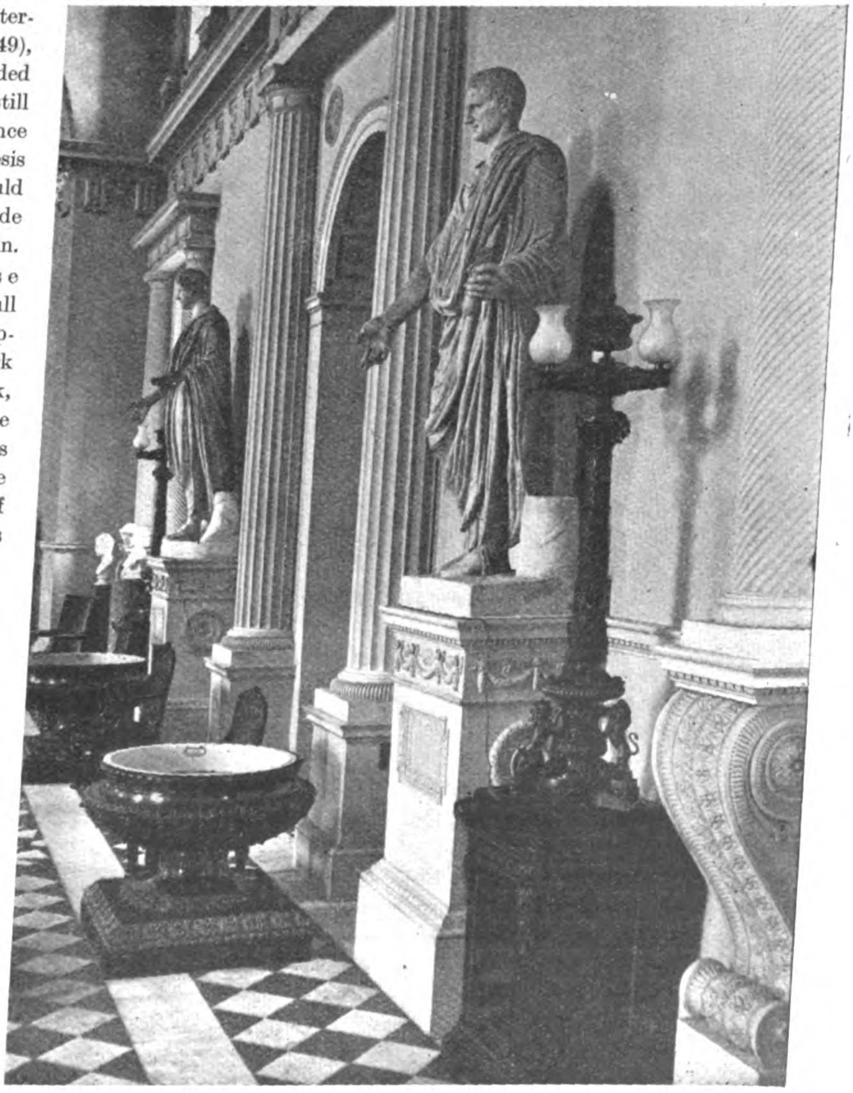
The Chinese School had the full approval of Chippendale, and work like Clandon Park, Surrey, shows the style that was fashionable in the earliest years of Robert Adam's commencing practice.

To the Italian votaries Adam proposed a return to a strict following of antiquity, as it was to be seen in the *cryptæ*, or excavated chambers of the remains of Imperial Rome, and in the newly revealed houses and remains of Pompeii and Herculaneum.

The current French work he desired to reform altogether. He set out to abolish "the absurd French compositions of this kind (interior decorations and fittings) hitherto so servilely imitated by the upholsterers of this country" (England).

Sir John Soane, in his lectures to the students of the Royal Academy, some twenty-five years after Robert Adam's death, asserts that the interlaced C scrolls, and other features of current French taste, were in actual fact for the time being driven out by Adam's reformation of the taste of his day.

The Chinese mode Adam left entirely on one side, the only concession being that, in such early work as that for the Queen of the "Blue Stockings," Mrs. Montagu, in Hill Street, 1766, he uses some Chinese pagoda-like details in the regularly disposed panels of the ceiling.



SYON HOUSE. DETAIL IN HALL.

Adam at first had considerable difficulties in bringing his executants to relinquish the well-established class of detail to which they had grown accustomed. Even in the execution of designs as late in date as 1774, as for instance the piano for the Empress Catherine, he has reason to complain that the person who

executed the work had departed from his design.

Some of the early mirror frames at Osterley can be seen to be much superior in design to their execution, and it was only where he had full control that the whole of the interior, furniture, hangings, etc., of his houses are completely true to his ideal.

The stages of Robert Adam's development are quite sufficiently marked out. Shardeloes, in Buckinghamshire, is as characteristic of the earliest stage as Home House in Portman Square is of the latest.

The actual first work, some interiors at Hatchlands, near Guildford, for Admiral Boscawen (1759–60), are clearly the student work of the young architect, on his first return from the rich storehouse of Italy. A much more serious note is struck at Syon, where the length of time over which the work extended enabled Adam to develop his ideas from the early style of the hall and dining-room to the later phase of the drawing-room and gallery.

At Kedleston the Adam scheme was hampered by the pre-existing and partly executed design of Brettingham and James Paine. Some of the work there is closely allied to Shardeloes and Syon, but a variety of difficulties prevented the full development of Robert Adam's ideas, in spite of the mass of alternative drawings, that he had made. The Great South Front, which was to be an example of his principle of "movement," remains as a fragment, a noble centre, devoid of the wings and quadrant connections, which were essential to its full effect.

This idea of "movement" is really a recognition by Robert Adam of the principle that lay behind the work of the later Roman school of Bernini and Borromini. The Italian Barroque had been a revolt against the over-systematisation of the orders, and was a claim to treat buildings as a sculptural unit that could be shaped at will, as an affair of relative masses, dependent on light and shade for an effect which might even become merely pictorial.

Unfortunately this late Italian claim for freedom was pushed to a license, which revelled in a mere inversion of recognised details, rather suggestive of a certain poverty of original invention. It has hardly been recognised that Robert Adam had ever given attention to the work of the late Roman school. The facts have been established by an analysis of his library, which proves that he had collected a choice selection of books on the subject.

Evidently Robert Adam did not agree that the architects of this school were the "blockheads" of the famous letter from Sir William Chambers to his pupil Stevens at Rome. Of this epistle Chambers characteristically gave an identical copy to young Soane, upon his setting out in 1778 upon his grand tour.

We have, therefore, without doubt, the explanation why Robert Adam was the earliest to appreciate the real merits of his predecessor, Sir John Vanburgh, to whose genius he paid a discriminating tribute, years in advance of that by Sir Joshua Reynolds, which has been so often quoted.

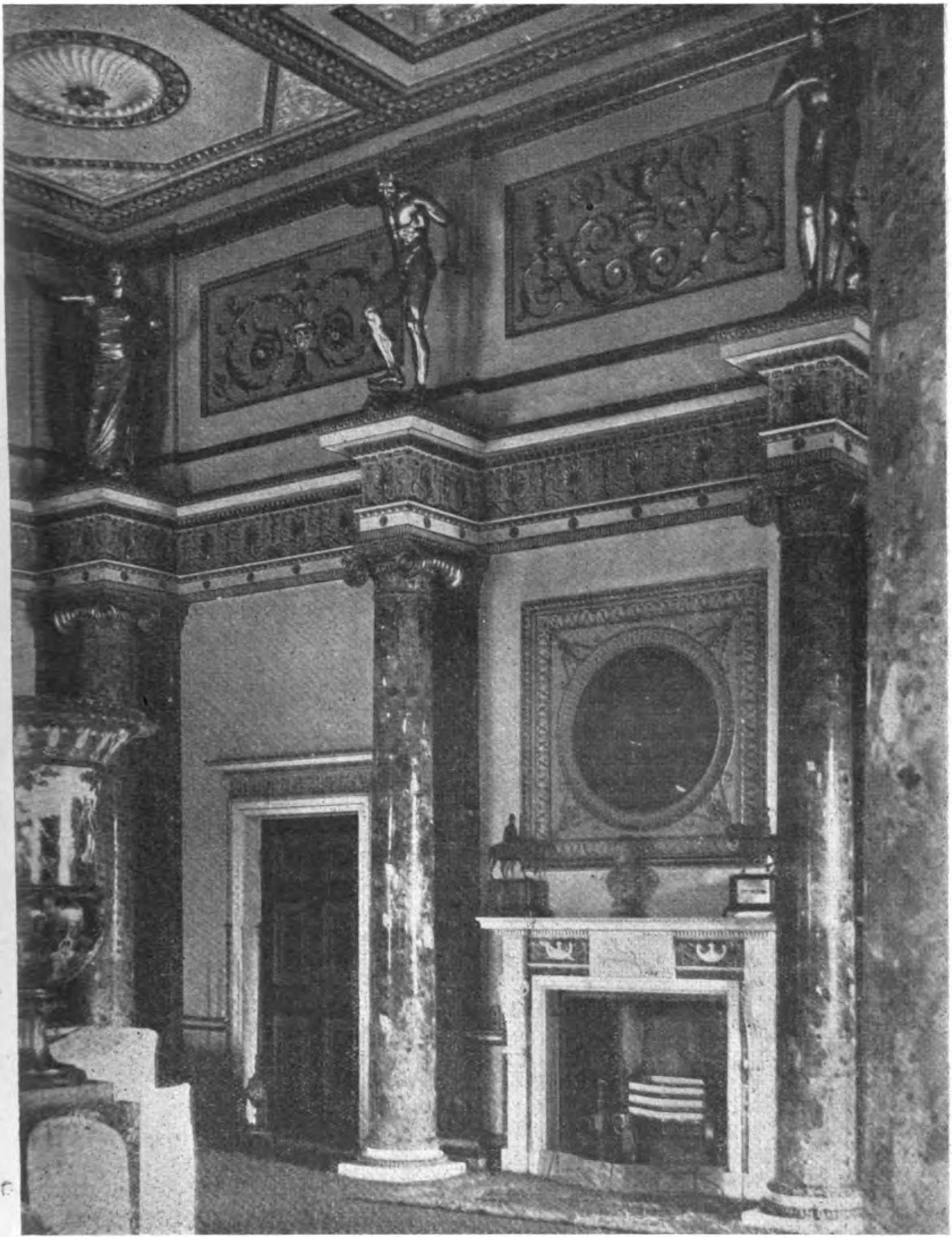
Adam had very early in his career added to houses by Vanburgh, as at Compton Verney and Kimbolton, he had certainly seen both Blenheim and Castle Howard, and thoroughly understood both the merits and defects of the earlier master.

Unfortunately, Robert Adam by the conditions and circumstances of his day never achieved that grand building, which was always in his dreams, and constituted the goal of his ambition.

At first he hoped for a royal palace for the new King, or at least for new Houses of Parliament, which would also involve new Law Courts. The Adelphi itself was really projected as a sample of a great work, worthy of comparison with the work of the Roman builders. A derelict and apparently useless sloping site was to be transformed by vast underworks raising it to the level of the Strand, where a fine terrace of houses was to demonstrate the possibilities of London improvements. Quays and warehouses below at the river level were to give a commercial backing to artistic enterprise, and this busy scene he, no doubt, saw in his mind's eye as a foreground, recalling the quays below the Imperial ruin of Spalato.

Only at the close of his life did the new University of Edinburgh afford him an opportunity of displaying his power of conceiving a great building as a whole, and of designing it in a style of broad simplicity, which surprises those who have merely considered him as an ornamentalist.

The Register House of Scotland, a much simpler problem, shows that Robert Adam could build with a simplicity and refinement that is truly Grecian. Robert Adam as an architect, in fact, demonstrates the truth that there is no real divorce between the extreme qualities of architecture. He seems by instinct to have adopted the same alternative as Sir Charles Barry in the case of the Houses of



Syon House. The Ante-Room.

Parliament, either absolute simplicity as in the elevations of the inner courtyards, or extreme elaboration as in the exterior façades of the new Palace of Westminster. The architectural quality demanded in both cases springs from the same root, a fine sense of unity in the design of the whole, by which the mass is never sacrificed to the detail.

The subordination in Robert Adam's finest work is complete, and extends to every detail, all of which are so fused in the total effect that nothing is extraneous to the design.

In his early interiors Adam was hampered by the enthusiasm of the period for the statues of antiquity. The recovery of the Greek masterpieces, through the copies of the Roman School of Antiquity, was one of the great interests of the day.

Niches were required for the Venuses, Floras, Dianas, Jupiters, and Apollos of the old Pantheon. The early Adam hall, dining room, staircase, and even the gallery, became the scene of such displays. At Syon there are three great statues on either side of the mantelpiece. Bas-reliefs, where originals were not forthcoming, are given in chiaroscuro paintings. Adam soon realised the unsuitableness of this scheme of decoration for an English interior, and, while he considered that the dining room in particular should be in stucco, so that a "smell of the victuals" might not hang about that apartment, he turned to other and more characteristic forms of decoration.

For the ceiling of these rooms an oval band, supported by wreaths of vine leaves, and enclosing crossed lines of the Bacchic thyrsus, is an early and constantly recurring motive. The band is later on interrupted and strengthened by tablets, presenting miniature bas-reliefs of classical composition.

The walls divided out into large panels above a chair rail are either filled with stucco arabesques, or left as a field for inserted portraits, or decorative landscape compositions, most often introducing ruins, antique or castellated.

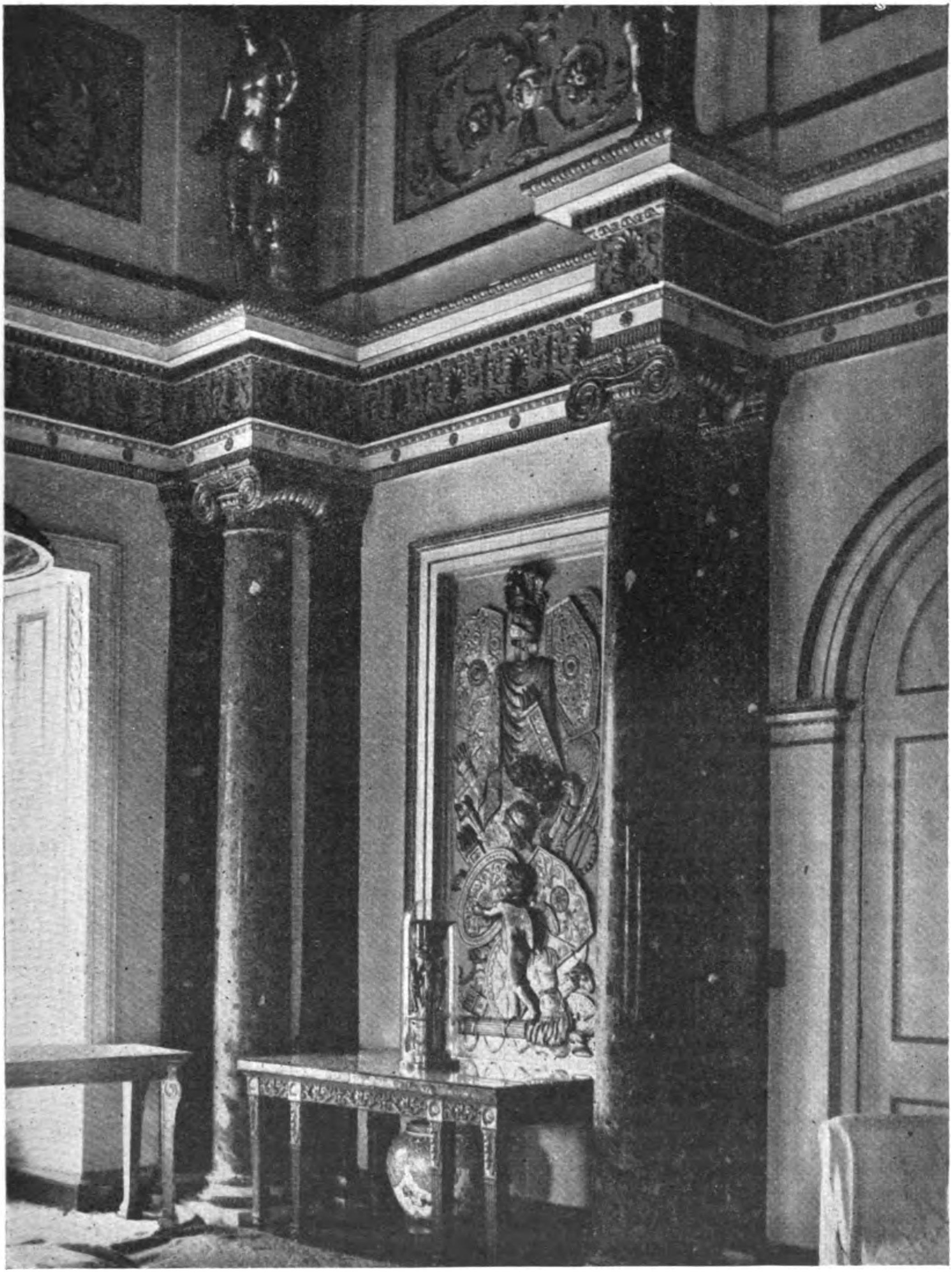
Ruins and the elements of picturesque decay had a singular fascination for an age and society which, perhaps, had a subconscious feeling that it was itself drifting towards the Niagara Falls of the Great Revolution.

Robert Adam's ruin compositions have, however, another purport in that they are essays in design, quite as much as recollections of the past impressions of his days of travel. During the slack period, following upon the American, French, and Spanish wars, he made a number of these compositions; there are some forty in the Soane Collection alone. They can be divided into two main groups—those which derive their romance from the ruins of antiquity, and others which recall his early days in the Highlands. In the latter group massive castles crown craggy heights above lakes, or rushing streams of water, crossed by long low arches of masonry. Robert was dreaming of rotundas masked as circular dungeon towers, whose buttresses should be linked together by a chain of arches, forming a ring of powerfully shadowed recesses. This revived feudalism was not to be extended to the interiors.

Culzean Castle, in Ayrshire, while castellated externally, is pure Adam classic within. His anticipatory mediævalism, where not a concession to the desires of his clients, was, in fact, due to a prepossession of his own that a broken craggy site was a reason for a design of a castle-like character. Possibly, if his travels had extended to the homeland of Greek architecture, he would have received a different impression from the relation of the temples to their mountain scenery and sites. The landscape school of gardening, originated as much by Kent as by any one person, was still in full possession of the field. Robert Adam seems never to have fully thought out the true relation of site and buildings. When he touches on that subject he seems to imply that buildings can be spread out, so as to rise up naturally out of the ground, a feat which even Blenheim cannot be said to have achieved. An Adam house in the country is apt to present the appearance of an isolated cube of masonry, seen under the most favourable circumstances at the end of a vista of trees. Terraces, forecourts, and garden walls had been proscribed by the destructive followers of Kent, and no real school of gardening existed to maintain the sound tradition derived from the gardens of Italy.

The primary object, however, of these compositions by Robert Adam was most likely that of affording ideas for the decoration of wall panels in interiors. He objected strongly to the vast pictorial compositions of the later Italian School, and their followers. Giulio Romano, in the Palazzo del Te at Mantua, had abused the Raphaelesque fresco as a means of interior decoration by an absurd attempt to obliterate the walls themselves, which presumably he had set out to decorate.

Vast canvases, in Adam's opinion, whether on the walls or ceilings, were a mistake. They trespassed on the field of architecture, and



Syon House. Detail in Ante-Room.

destroyed the scale as well as the necessary detail of the interior they purported to embellish. At Syon, in the drawing room, Adam endeavoured to restrict the painter to small flying figures, occupying the field of the octagons and circles of the great cove, as well as of the flat of the ceiling. Undoubtedly, in this instance, the figures are too small, and hereafter Adam provides medallions and lunettes, or oblongs and squares, as panels forming an essential feature of his intricate ceiling designs. In these spaces there is room for three or more figures, and the simpler classic myths are recalled by these graceful compositions.

Constantly these panels are shown in colour sketches on the detail drawings of ceilings and walls. A great variety of artists must have been engaged on works of this character, which so often now are merely ascribed to Zucchi and Angelica Kauffmann. Hamilton is particularly mentioned by Soane as preferred to the elder Smirke, R.A., who seems to have been occasionally employed by James Wyatt. The chief artist for the latter architect, however, was Biagio Rebecca.

Silk as a substitute for the costly tapestry was often employed for the drawing rooms, either in plain colours, or woven in patterns as at Syon, where the wall covering is said to be the earliest of the Spitalfields silk damasks.

Tapestry is seen in all its glory at Newby. There were four famous sets by Boucher and Neilson. The others have been at Croome, Arlington Street, and Osterley.

The drawing-rooms at Newby and Osterley are glorious pieces of colour. Every detail has been successfully combined by Adam in the general effect of the whole. He had already in the great room at Kenwood experimented in the direction of subduing the glare of a purely white ceiling ornamented in stucco by flat washes of colour. This was a very different method from the tiresome "picking-out" of parts in colour and gold, which followed in the early part of the next century. As used by Robert Adam this colour treatment is essentially a wash, intended to blend the effect of the whole, and not to isolate particular ornaments, or lines of mouldings.

Given tapestry or figured silks on the walls, woven pattern fabrics on the furniture, finely embroidered clothes, and a carpet reflecting the elaborate design of the ceiling, all with details and tones of pure, bright, and strong colour, it is elementary that a full accord would require the extension of colour to the ceiling itself.

The typical Adam interior of the period 1770–80 stands in a striking contrast to that of the antecedent age of the first two Georges, in respect of every detail that contributes to the total effect of the taste of the age. Pattern design, whether in form or colour, reached a high level, and fragments of the style have persisted, and reappear in common use, to the present day.

It is natural to inquire how far the development of Robert Adam's idea of interior treatment was modified in the course of his practice. It is possible to recognise three stages, the first in which the ornamentation, while classic in comparison with French rococo, is yet more florid and scroll-like than the work of the true Adam character. The main period is that in which architectural lines and classic types are fully observed. In the third stage a tendency to relax this severity of form may be detected, and there is an occasional use of flowers, which border on a merely naturalistic treatment.

Probably Robert Adam found it difficult to resist the pressure of common opinion, which fails to recognise the limits of the direct application of natural forms. Very few are aware of the long course of evolutionary change, which has shaped the well-established forms of classic mouldings and enrichments. The attempt to supplement these by direct transcripts from natural objects has very rarely been successful or permanent. It seems clear that Robert himself was content with the alphabet of the art of decoration, and that such attempts as those of the "Britannique order," the "Scotch capital," etc., are merely due to James Adam's vague imaginings. There was a good deal of the amateur in the composition of the third member of the Adam group.

Contemporary critics, who talked about the superior chasteness of James Wyatt's use of the antique, failed to see that Robert Adam had the better sense of the all-important distribution and spacing of ornament. His combinations of lines, and special gift of pattern-making, saved him from a variety of false effects, which are to be seen in the work of his rival Wyatt and of his colleague James Stuart.

The colour decoration of Wyatt is also inferior, because it is so often based upon an imitation of the least attractive phase of the Raphaelesque. It may be said that while Adam might have been taught by Raphael himself, Wyatt had sat at the feet of Giulio

Romano. The Cupola Room at Heaton Hall shows the hot type of colour that Wyatt favoured. Robert Adam's most original contribution to colour effects was, perhaps, the combination, which he labelled as "Etruscan Decoration."

In an age which demanded the sanction of antiquity for any fresh departure, such a label had obvious advantages. Adam puts forward an array of authors, but he is careful to explain that not much is to be gathered from them on this subject of "Etruscan Decoration." The real idea at the back of his essay was a sense of the values of earth colours, bright and dull reds, yellows, grey blues, chocolate browns and black. Horace Walpole talks of being plunged into a "chilly bathos" by the Etruscan Room at Osterley. The simplicity of the scheme startles him. He does not understand this reliance on the earliest principles of decoration, those by which a few of the simplest colours are disposed in direct contrast of hue.

So much of this interesting colour work has been obliterated by later fashion that very few examples exist in sufficient completeness. The Etruscan scheme was applied throughout walls, ceilings, hangings, carpets, and furniture. Occasionally the mantelpiece of white marble inlaid with composition is all that remains to show the original character of the colour scheme of the "Etruscan Room."

The general knowledge of antiquity, its literature, legends, and myths, as well as the common forms of their expression in ancient art, amongst the class for whom Robert Adam chiefly worked, was a valuable background for his achievements. As a source of expression the original fables were current coin. The choice of Hercules, or of Paris, the continence of Scipio, the sacrifice of Iphigenia, and the rest of the typical myths needed neither label nor explanation. To-day many of the Adam bas-reliefs and subjects of decoration have become merely a riddle to the spectator who misses the application that suggested their particular use. This power of applying universal symbols, for the expression of particular qualities, was of great assistance in the use of sculptural decoration. Abused by dulness it degenerated into an impossible conglomeration of tiresome allegorical figures, such as the great war soon after piled up under Academical auspices in the Abbey and St. Paul's.

It is worthy of note that where Robert Adam used pairs of life-sized figures in his earliest and favourite form of chimney-piece, he seems to give them no special characteristics. Their aspect is purely decorative and unhampered by any forced significance. The same seems true of the Syon Bridge design, where the three female figures have no greater characterisation than that of a group of the three Graces. This avoidance of an overcharged expression in sculpture is a lesson of the greatest value.

These lectures are not the place in which to deal with the architectural qualities of Robert Adam's planning. All that need be said here is that as house-builder he has had few equals. Numbers of his houses remain practically unaltered, and their continued occupation for more than four generations testifies in a remarkable way to their merits.

It should be pointed out, however, that in sectional treatment Robert Adam never resorts for effect to the experimentalism of George Dance and John Soane. There is no hint of eccentricity in his classic schemes, which remain true to the antique ideal of simplicity and repose. Adam taught and practised the necessity of variety, in contradistinction to the dulness of that series of oblong and square interiors, which had prevailed in the earlier Georgian times. He points out the value of the progressive effect ending in a climax, but he arrives at such a result without apparent effort, or any straining after a *coup-de-theatre*, in the manner of a Jesuit church, or late Roman Renaissance interior. This Grecian moderation is all the more remarkable because Adam was the earliest to appreciate the real merits of his predecessor, Sir John Vanburgh, and, as we have seen, he had a knowledge of the Italian barroque, and had been a close ally of Piranesi.

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BRITISH ASSOCIATION.

Presidential Address.

The Cardiff meeting of the British Association opened on Tuesday, when Dr. William A. Herdman, F.R.S., Professor of Oceanography in the University of Liverpool, delivered the presidential address, his subject being "Oceanography." After reference to the founders and pioneers of the "science of the sea" he outlined some of the investigations and problems which had appeared to him to be of fundamental importance, of economic value, and of general interest. "We can," he said "scarcely hope in European seas to add new food-fishes to our markets, but much may be done through the co-operation of scientific investigators

of the ocean with the Administrative Departments to bring about a more rational conservation and exploitation of the national fisheries."

During recent years one of the most important and most frequently discussed of applications of fisheries investigation had been the productivity of the trawling grounds, and especially those of the North Sea. It had been generally agreed that the enormous increase of fishing power during the last forty years or so had reduced the number of large plaice, so that the average size of that fish caught in our home waters had become smaller, although the total number of plaice landed had continued to increase up to the year of the outbreak of war. Since then, from 1914 to 1919, there had of necessity been what might be described as the most gigantic experiment ever seen in the closing of extensive fishing grounds. It was still too early to say with any certainty exactly what the results of that experiment had been, although some indications of an increase of the fish population in certain areas had been recorded.

It had been shown by Johnstone and others that the common edible animals of the shore might exist in such abundance that an area of the sea might be more productive of food for man than a similar area of pasture or crops on land. A Lancashire mussel bed had been shown to have as many as 16,000 young mussels per square foot, and it was estimated that in the shallow waters of Liverpool Bay there were from 20 to 200 animals of sizes varying from an amphipod to a plaice on each square metre of the bottom.

From these and similar data it was not difficult to calculate totals by estimating the number of square yards in areas of similar character between tide-marks or in shallow water.

Countings and weighings, however, did not give them all the information they needed. It was something to know even approximately the number of millions of animals on a mile of shore, and the number of millions of tons of possible food in a sea area, but that was not sufficient. All food-dishes were not equally nourishing to man, and all plankton and bottom invertebrata were not equally nourishing to a fish. At this point the biologist required the assistance of the physiologist and the bio-chemist. Dr. Johnstone had already shown how markedly a fat summer herring differed in essential constitution from the ordinary white fish such as the cod, which was almost destitute of fat.

Professor Brandt, at Kiel, Professor Benjamin Moore, at Port Erin, and others had similarly shown that plankton gatherings might vary greatly in their nutrient value according as they were composed mainly of Diatoms, of Dinoflagellates, or of Copepoda. And, no doubt, the animals of the "benthos," the common invertebrates of our shores, would show similar differences in analysis. It was obvious that some contained more solid flesh, others more water in their tissues, others more calcareous matter in the exoskeleton, and that therefore weight for weight they might be sure that some were more nutritious than the others; and that was probably at least one cause of that preference they saw in some of our bottom-feeding fish for certain kinds of food, such as polychaet worms, in which there was relatively little waste, and thin-shelled lamellibranch molluscs, such as young mussels, which had a highly nutrient body in a comparatively thin and brittle shell.

His object in referring to these still incomplete investigations was to direct attention to what seemed a natural and useful extension of faunistic work, for the purpose of obtaining some approximation to a quantitative estimate of the more important animals of our shores and shallow water, and their relative values as either the immediate or the ultimate food of marketable fishes.

"To attain to an approximate census and valuation of the sea—remote though it may seem—is," he said, "a great aim, but it is not sufficient. We want not only to observe and to count natural objects, but also to understand them. We require to know not merely what an organism is—in the fullest detail of structure and development and affinities—and also where it occurs—again in full detail—and in what abundance under different circumstances, but also *how* it lives and what all its relations are to both its physical and its biological environment, and that is where the physiologist, and especially the bio-chemist, can help us. In the best interests of biological progress the day of the naturalist who merely collects, the day of the anatomist and histologist who merely describe, is over, and the future is with the observer and the experimenter animated by a divine curiosity to enter into the life of the organism and understand how it lives and moves and has its being."

In conclusion, he appealed to the population of these islands, a maritime people who owe everything to the sea, to become better informed in regard to our national sea-fisheries, and take a more enlightened interest in the basal principles that underlie a rational regulation and exploitation of these important industries. "National efficiency depends to a very great extent upon the degree in which scientific results and methods are appreciated by the people, and scientific investigation is promoted by the Government and other administrative authorities. The principles and discoveries of science apply to aquiculture no less than to agriculture. To increase the harvest of the sea the fisheries must be continuously investigated, and such cultivation as is possible must be applied, and all this is clearly a natural application of the biological and hydrographical work now united under the science of Oceanography."

COLLOIDAL FUEL.

By George Howell, F.G.S., F.R.G.S.

In following up the suggestion made by Mr. Arnold Lupton, and the editorial note which appeared in your issue of August 13th, I would like to add a few remarks.

The mixed system of coal and liquid fuel combustion is now becoming an important investigation, in view of the absolute necessity to conserve both oil and coal and to make wastage a thing of the past.

It has clearly been demonstrated, over and over again, that in combination the combustion of these two fuels is not only possible but has been put to practical test and economic use in the navies of the world and in many engines of modern type. Coal-dust we know produces a better combustion, while with oil the heat is better utilised. M. Bertin says: "Where 5 kilos. of coal would ordinarily develop each 7,800 calories, they will produce 9,200 calories, a gain of 7,000 calories. The excess of air supplied with the 5 kilos. of coal would be 20 cubic metres, and this would suffice for the added kilogram of oil, and produce 11,000 calories with no further air supply. A total of 18,000 calories compared with the original output of 7,800 calories per kilo. of coal, makes the ratio of oil to coal appear 2·31." This ratio is important when considering storage, as economy in ship-space is also a serious consideration.

Obviously coal-dust and oil in combination establish great economic possibilities, not only in efficiency but in conservation of both fuels. It is also obvious that applied air constitutes a "fuel" in itself. This is illustrated in the Bessemer steel process used for the manufacture of cast steel.

The convertor, mounted on trunnions, when in operation, is tilted down almost to an horizontal position, when the hot metal is received from the cupolas. It is then tilted back to its original, vertical position. Immediately on adjustment of vertical position, high-pressure air currents are passed through the mass from tubes placed in the bottom of the convertor; the temperature is thereby very materially increased without the use of other fuel. The point here is that when a certain temperature has been reached, the air properly conducted constitutes a fuel in itself. The open door of a furnace, however, especially in marine engines is not only an enemy to maintaining temperature but is injurious to the tubing of the boiler. It, therefore, follows that until coal-dust can be fed by fan-blast, in fixed proportion of air and coal-dust, thereby maintaining a uniform temperature and a maximum efficiency of heat-units, coal-dust cannot be a substitute for oil and coal acting in combination.

During the current year the establishing of a perfect fuel in colloidal form is to engage the attention of the Institution of Petroleum Technologists, and serious research work is now being carried on to effect economies in, and also to conserve, petroleum and coal.

On the 16th November next, at 5.30 p.m., Mr. Lindon W. Bates is to read a paper on "Colloidal Fuel" before the members of the Institution of Petroleum Technologists, and on that occasion the Council offer a welcome to all Fellows of the Royal Society of Arts.

ALGERIAN PHOSPHATE INDUSTRY.

The Algerian phosphate deposits are situated in the Department of Constantine, the most important being at Djebel-Kouif in the region north-east of Tébessa, exportation taking place principally from Bône and to some extent from Bougie.

The phosphate industry, in common with the mining industry in general, was adversely affected by the war through the reduction in personnel and working force, the impairment of the railway service, the scarcity of tonnage, the intense submarine campaign in the Mediterranean during the latter part of the war, and the loss of various European markets.

Before the war Germany was the best customer for the Algerian phosphates, taking 118,464 metric tons out of a total exportation in 1912 of 377,601 metric tons. In 1916, exports reached the highest point during the war, amounting to 322,533 metric tons. Spain took the largest share, followed by Great Britain and Italy. Owing to the various obstacles above mentioned, exportation in 1918 was less than half that of 1913. Official statistics give the following figures of the exports of phosphates in 1912-1918:—

	Metric tons.
1912	377,601
1913	438,601
1914	355,140
1915	225,868
1916	322,533
1917	234,825
1918	198,539

It is thought that the phosphate industry will take on new development, as the intensification of agricultural effort in the countries that were at war will create a large demand for Algerian and Tunisian phosphates.

Two important factors in the development of this industry, writes the United States Consul at Algiers, are the improvement of railways and of methods of extraction. Railway amelioration will require considerable time. An illustration of the new development in production is given by the Compagnie des Phosphates de Constantine, which is by far the largest concern now engaged in the phosphate industry. This company has recently set up in its establishment at El-Bey, near Tébessa, a new factory, which produces 100 tons of phosphates per hour. This factory is said to have the largest capacity in the colony, being provided with the latest equipment to economise labour and coal. The phosphates are, in fact, sorted, crushed, pulverised, dried, and put in storage or loaded on railways trucks entirely by mechanical means. The plant has storage facilities for 55,000 tons, one operator only being necessary for loading and unloading.

Owing to the transportation difficulties, the chemical producing establishments at Oran have had to close. Last year the Government limited to 16,000 metric tons the quantity of phosphates put at the disposition of the Algerian factories on account of the insufficient means of transportation.

There are three plants for the production of sulphuric acid and superphosphates in Algeria, situated at Oran, Maison Carrée (near Algiers), and Bône. These factories could produce 86,000 tons of superphosphates annually, which would exceed the requirements of the country and leave a balance for export.

OBITUARY.

Maurice George Carr Glyn.—Mr. Maurice George Carr Glyn, partner in the banking firm of Messrs. Glyn, Mills, Currie & Co., died at his residence, Albury Hall, near Bishop's Stortford, on August 21st. Born in 1872, he was the second son of the late Hon. Pascoe Charles Glyn, M.P., and grandson of the first Lord Wolverton. He was a Justice of the Peace for Hertfordshire and Middlesex, and occupied the office of High Sheriff of the former county in 1912. He was a director of the London and Brazilian Bank, the Liverpool and London and Globe Insurance Company, Messrs. Dalgety & Co., Ltd., and other companies. He was elected a life fellow of the Royal Society of Arts eight years ago.

GENERAL NOTES.

Department of Scientific and Industrial Research.—The following Research Associations have been approved by the Department as complying with the conditions laid down in the Government scheme for the encouragement of industrial research and have received licenses from the Board of Trade:—British Boot, Shoe and Allied Trades Research Association, Northampton; British Cotton Industry Research Association, Manchester; British Empire Sugar Research Association; British Iron Manufacturers' Research Association, Manchester; Research Association of British Motor and Allied Manufacturers; British Photographic Research Association; British Portland Cement Research Association; British Research Association for the Woollen and Worsted Industries, Leeds; British Scientific Instrument Research Association; Research Association of British Rubber and Tyre Manufacturers; Linen Industry Research Association, Belfast; Glass Research Association; British Association of Research for Cocoa, Chocolate, Sugar Confectionery, and Jam Trades; British Non-Ferrous Metals Research Association, Birmingham; British Refractories Research Association; Scottish Shale Oil Scientific and Industrial Research Association, Glasgow.

Dairy Industry in South Africa.—The dairy industry in South Africa has now assumed a position of considerable importance. Whereas a few years ago very large quantities of butter and cheese were imported, during the twelve months 1916-17, according to *Production and Export*, not only was sufficient butter made in the Union for all local requirements, but a surplus of over 4,000,000 lb. was exported overseas. The production of cheese during the year 1917 also increased rapidly, and large quantities have been sold and exported. The Union may therefore now be said to be self-supporting as regards butter and cheese, while there is every prospect of a remunerative export trade developing in both commodities. Experience has thus shown that a very considerable portion of the Union was well adapted to dairy farming. The climate is mild, and cattle thrive well on the natural veld from six to eight months of the year. Dairying is no longer looked upon as a side-line by farmers; large numbers are now specialising in dairy-farming and improving their cattle, with a view solely to increasing their output of milk and cream, while the arable portions of their farms are devoted entirely to the production of foodstuffs for the feeding of their cows. The principal crops grown for the feeding of dairy cattle are mealies, lucerne, oats, teff-grass, millet, mangolds, rye, and cow-peas, all of which do well in most of the areas devoted to dairy-farming. Considerable quantities of mealies are grown for silage and mealie hay, the use and value of which are being increasingly realised. It may be said with confidence that the outlook for the dairy industry in South Africa is very bright, and if the present rate of progress is maintained a great future is assured.

Black Sea to North Sea and Baltic Waterway.—The Prague Government, according to the *Marine Journal* (U.S.A.), is about to embark upon a large scheme of inland navigation. The Peace Treaty granted the Czecho-Slovak Republic free transit on the Elbe and Oder to Hamburg and Stettin, where Germany is to accord free port facilities. It has now been decided to canalise the middle Elbe and to connect it with both the Danube and the Oder. Czecho-Slovakia will then be traversed by a waterway reaching from the North Sea and the Baltic *viâ* the Danube to the Black Sea.

Shipbuilding on the Straits of Magellan.—The largest vessel built on the Straits of Magellan was launched recently at the yards of La Sociedad Ganadera Gente Grande, a Chilian company under English management, at Puerto Harris, Isle of Dawson. According to the American Consul at Punta Arenas, it is a wooden gas-screw schooner of 900 tons displacement, and is equipped with two motors of a combined capacity of 200 h.p. The vessel has a length of 142 ft., a beam of 28 ft., and a draft of 12 ft. All the wood used in its construction was cut on the Isle of Dawson. The schooner will be operated by La Sociedad Ganadera Gente Grande, which is extensively engaged in sheep farming as well as in lumbering and boat-building. This concern recently built two lighters for use in connection with a meat-freezing plant at Santa Cruz, Argentina. A wooden steamer of 125 tons capacity has been built at Punta Arenas for a local firm. It will be used in Straits traffic.

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All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE ARCHITECTURE AND DECORATION OF ROBERT ADAM AND SIR JOHN SOANE, R.A. (1758–1837).

By ARTHUR T. BOLTON, F.S.A., F.R.I.B.A.,

Curator of Sir John Soane's Museum.

Lecture II.—Delivered May 10th, 1920.

I propose to deal in this second lecture with a brief selection of some of the principal Adam houses, more particularly with reference to their interiors, in a sequence of dates.

It is impossible to do more than merely outline a few of the principal points in each case, and I can only refer you to the two folio volumes, now in the press, in which I hope to give a full and adequate survey of the vast subject of the work of that gifted and versatile artist, Robert Adam.

Hatchlands.—At Hatchlands, near Guildford, in Surrey, in a very dull house, reminiscent of the old Admiralty, without, however, any portico, Robert Adam made his first essay in interior decoration following upon his return from his grand tour in January, 1758.

Ripley, the carpenter, who was the architect of the Admiralty in 1724–6, was probably that of Hatchlands as well. He died February 10th, 1758, less than a month after Robert's return.

As Admiral Boscawen (1711–1761), the hero of the capture of Louisburg (1758), returned in November of that year and sailed again on April 14th, 1759, the date of the Adam drawings can best be placed quite early in the latter year.

The Admiral's monument in Cornwall states that he had just finished the work at his death, January 10th, 1761, and less than two years would be little enough time for the execution of the Adam work at Hatchlands. Robert's share must be confined to the completion of some of the chief rooms. Naturally the work is unrestrained in design and seems bursting with all the enthusiasm of a recent return from Italy. The actual work is better than the drawings, and the design evidently underwent a process of revision in execution, though one less chastened than would have been the case after even a brief experience on the designer's part of actual work.

The centre room of the chief front, the present Great Drawing Room, is the interior with which the principal Adam drawings that remain are concerned. The ceiling is centred on an oval, enclosed by the strong lines of a prolonged octagon, with an outer border enlivened by sea horses in relief. The concentration of ornament in the corners is an Italian feature. The walls are simply framed up into panels, which in Adam's drawing are filled in with arabesques in stucco, of the type of those which exist at Shardeloes. Two paintings of ruins are shown in the centre panels, with a subject-piece enclosed in the overmantel frame. The fine white marble mantelpiece displays a pair of tall graceful figures, a composition which was Robert Adam's earliest ideal. The adjoining Library has even more character. The scheme of the ceiling seems to have a personal reference to the hero's career. The set-out is a radiating scheme of panels with an effect rather resembling that of the gussets of an octagonal dome. The four main figures in these spaces are Neptune, Justice, Fame, and Victory, the last being a figure with a laurel wreath and palm branch. The alternating panels are filled in with twin mermaids rising from a base of cannons, rifles, anchors, flags, swords, spears, and even drums, a mass of decorative symbolism dear to the heart of the eighteenth century. The whole design has evidently a monumental significance and symbolic intent.

The mantelpiece in white marble, of which the drawing exists, is interesting as an early example when Adam was disposed to follow massive architectural types.

There was a great salon upstairs which no longer exists. The ceiling was based on a great oval, the band of which was filled in with octagonal coffering.

The abiding interest at Hatchlands will always be that of possessing the earliest decorative essay of Robert Adam after his return from Italy.

Shardeloes.—Shardeloes, near Amersham, in Buckinghamshire, may be regarded as the first house, though here also some building work was already in hand, before Adam came on the scene.

The interiors of this house illustrate the claim, made by Robert Adam in his preface to the "Works" of 1773–8, to have effected a revolution in the taste of the age:

"In the decoration of the inside, an almost total change, the massive entablature, the ponderous compartment ceiling, the tabernacle frame, almost the only species of ornament formerly known in this country, are now universally exploded, and in their place we have adopted a beautiful variety of light mouldings, gracefully formed, delicately enriched, and arranged with propriety and skill. We have introduced a great diversity of ceilings, friezes and decorated pilasters, and have added grace and beauty to the whole, by a mixture of grotesque stucco and painted ornaments, together with the flowing *rainceau*, with its fanciful figures and winding foliage."

Shardeloes represents, of course, the origination rather than the full accomplishment of these ideas. As an early work it has a strong hold on what had gone before, with all the fresh interest added of the germinating stage of a new manner.

In the interiors we see the heavier and bolder ornamentation of the beginner, who has not yet shaken himself free of the earlier Georgian style. The wild curves and scrolls of leafage, in this preliminary essay at Shardeloes, as also in the first Adam designs executed at Kedleston, had yet to be subdued and harmonised into a new system of low relief decoration of a classical and restrained architectural character.

The wall decorations of the Dining Room are perhaps the most symptomatic achievement at Shardeloes, work which seems to call for less of the taming process than the ceilings throughout the house, which very probably were the first work executed. In these wall panels the sphinxes and the inserted bas-reliefs, which were to form the central *motifs* of his system, already appear and strike the true Adam note. The finish and delicacy of the later work are indicated rather than achieved at Shardeloes.

The house interiors remain here seemingly the same and untouched. The wall colourings are now faded to pleasant tones of green, lilac, and grey, while the ceilings are mostly white.

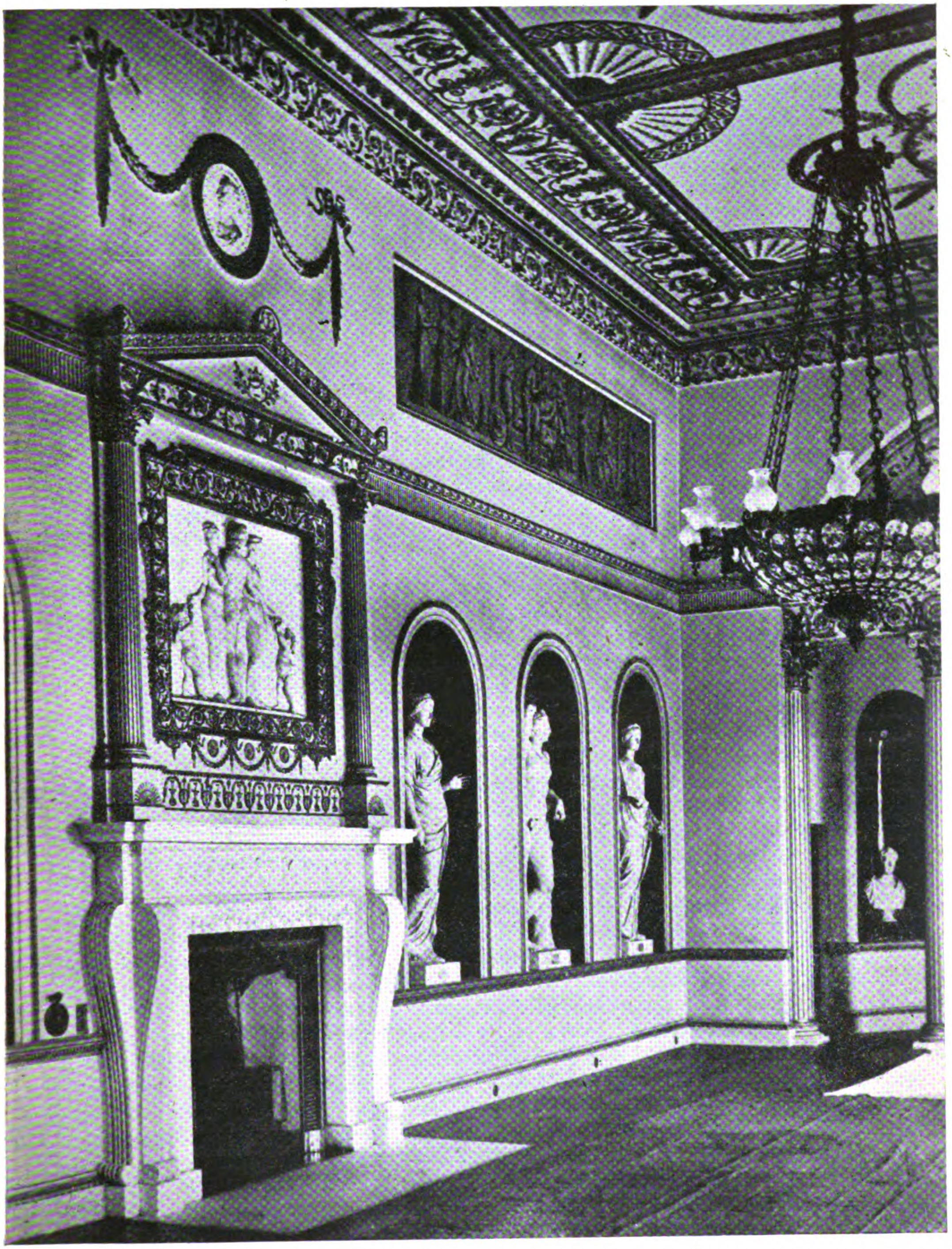
The doors, double owing to the thickness of the walls, are magnificent specimens of mahogany, aged to the colour of a tawny port wine, and dulled in polish to a delightful surface.

The Salon, entered from the great portico in the centre of the east front, is a stately hall in that form of Doric, which Adam afterwards developed so effectively at Lansdowne, Harewood, and many another of his great houses.

The Dining Room at the northern end of the east front is a fine interior, richly decorated. The ceiling has a large oval band crossed by very free-flowing foliage, like a chain of wreaths. The crossed thyrsi and the ivy in the centre are an obvious reference to Bacchic rites. As a whole this design suffers from heterogeneous effect of elements insufficiently welded together. Adam, more than once, using the same idea, hereafter effected great improvements on this early composition.

The Drawing Room, in cream colour, contrasts with the faded blue of the Salon. Relief is afforded by two fine mirror frames in gold on gilded console-tables with quadrant tops of scagliola. The ceiling presents a central circle with four lions' heads linked together by bold swags. Four fans are introduced, features which Adam afterwards developed with great effect. Here again the somewhat wild scrolling on the ceiling illustrates the early date of the work.

The Library, occupying the centre of the south front is perhaps as characteristic as any of these interiors. It may be regarded as the first of those rooms, dedicated to books, of which he produced so fine a series. The distribution of the south window-wall takes the form of a shallow arcade, the bookcases being worked in as projections on the piers. The other walls are entirely lined for two-thirds of their height with white painted deal casings framing up wire panel doors, behind which the books are visible. The entrance doorways to the room are brought into the scheme, so that the line of the book casing is preserved throughout. Above are a series of panels filled in chiaroscuro paintings on green grounds, like a Wedgwood cameo relief on a large scale. The fine mantelpiece is of white marble with Sienna yellow insertions. It has long fluted consoles and a vase in low relief on the central panel of the frieze.



Syon House. Fireplace in Dining-Room.

Harewood.—The Adam drawings for the interior of Harewood, in Yorkshire, form an important group of designs all dated 1765. The carcase of the house had been in progress from about 1760, John Carr, of York, being the local architect on the spot working in conjunction with Adam, more particularly in reference to the exterior and the plan, which both represent a compromise between the older tradition and Robert Adam's newer ideals. Adam's plans and elevations for interiors at Harewood occupy many sheets of drawings, and show more work even than was ever realised. They cover the whole of the interior, and include accessory buildings, which do not appear to have been built. Each room is shown by a separate sheet, giving a detail plan, with the four elevations of the walls drawn round it. The correspondence of these drawings with the actual work shows that extraordinary fidelity which astonishes us in Adam's executed works. The detail can be authenticated by the photographs I have had taken in all cases, proving that what Robert Adam designed was faithfully produced.

Many alternative first and second designs exist, but once the drawing was approved, the work seems henceforth to have been carried through exactly as it was shown by him. It is a great testimony to the confidence that was placed in Adam, and to his own power of realising his intentions. The Hall at Harewood is on a large scale and, though less imposing and masterly than that of Syon, is yet a monumental example of Robert Adam's work. The bold engaged columns, though unusual with him—he habitually used pilasters—are shown as of fully three-quarters' projection in his original design. The main feature of each wall is emphasised by an arch; in particular opposite to the entrance doorway was a deeply recessed archway with niches, which has since been filled up on the Hall side. The ceiling of the Hall is flatly treated with a central octagonal feature. On the walls are medallions and panels, and on the flag in one of them is the date 1767, which will be that of the completion of this interior, as the drawing for the Hall is dated 1765, and for the fireplace 1766.

The Music Room, entered on the right, is a fine Adam interior still possessing the original carpet, which reflects the design of the ceiling. The medallions on the walls are ascribed to Angelica Kauffmann, and the landscapes to Zucchi, while the portrait of the first Earl of Harewood, in an Adam frame, is by Hoppner. It should be noted that all Adam's drawings for the furniture at Harewood are missing. It is probable that they went direct to Chippendale, and were not returned.

The Great Gallery has been altered; the chimney piece has been moved to the Dining Room. It is a fine instance of the early type of a pair of tall graceful women. The frieze and enclosing mouldings were of ormolu, with a purple ground to the bas-relief panels. The figures were united by light and graceful swags.

The fine ceiling of the Gallery was carried out by Rose from a large coloured drawing by Adam dated 1769. It is exceedingly good in relative scale and ingenious in pattern.

The curtain boxes to the windows are characteristic, and the pendant valences, carved by Chippendale in wood, are so skilfully executed as to quite deceptively match the deep blue colour, as well as the fabric of the curtains.

This doubtless was so arranged to obviate the bad effect of the dust and corrosion of any woven material at that height.

The window piers have magnificent console-tables with mirrors over them. The latter follow a design, made by Robert Adam for Sir Lawrence Dundas in 1765, with interesting modifications of detail. The white marble tops have coloured inlays and gold framings. The ovals above were painted by Angelica Kauffmann.

The Salon in the centre of the south front has been altered by book-casings. Adam had placed screens of columns across the apses, with a pedimented doorway as a centre between them. The pair of splendid mantelpieces on the two side walls remain complete with their overmantles in exact accordance with his drawing. The centre composition which he shows is a "Sacrifice."

A tourist, writing in 1787, says: "All the rooms are equally elegant and costly, but the large Gallery and the Great Drawing Room present such a show of magnificence and art, as the eye hath scarce seen.... The Great Drawing Room is as handsome as designs and gilding can make it; here are seen elegant glasses, ornamented with festoons, particularly light and beautiful; also tables with same. The whole has been furnished only a year by Chippendale, of St. Martin's Lane."

The lesser Drawing Room was apparently an Etruscan room.

Croome Court, in Worcestershire, and *Bowood*, in Wiltshire, both present Adam work of the early period, but in each case they are alteration and decoration work to buildings, erected mainly by others, and need not be discussed here.

Syon House. Ceiling in Dining-Room.

Kedleston, Derbyshire.—James Paine tells us that in 1761 he prepared the designs for Kedleston which appear in his book. This vigorous but rather heavy-handed architect enjoyed a great reputation and an enormous practice in the North of England. His scheme was to build a centre block with four detached wings, connected by quadrant corridors treated as colonnades. The plan was never completed, and only two wings with their connections exist.

He says that he accepted the previous design of Brettingham for the four wings, but himself "planned the centre block and connecting corridors."

This bears out a memorandum by the first Lord Scarsdale, recording that he built the house between the years 1758–68, and makes it probable that Brettingham was the first architect.

Adam's earliest drawings relate to carpets and ceiling designs, and it would appear most probable that, at first, he was to complete the interior. He appears to have been already working in association with Paine at Alnwick.

The most marked feature of Paine's centre block was a great columned hall and a circular salon, between which he proposed to place the main staircase of the house. Subsequently, however, according to his own account, finding himself too busy in other parts of England to devote to the proposed building the close attention which so great a work required, he requested to be allowed to resign the task, "whereupon it was entrusted to those able and ingenious artists, Messrs. Robert and James Adam."

In point of fact he was very much preoccupied with Worksop, which had just been burnt down (October, 1761) a month after its completion.

From all this we may assume that Lord Scarsdale had lost faith in the scheme propounded by Paine, and that Robert Adam was called in to complete and particularly to decorate the structure.

Adam revised the plan by suppressing the great staircase, by which change of plan the idea of a great villa in the antique manner was better realised. The bedrooms above were purely secondary, and a minor staircase was all that was required. A grand suite of unbroken state apartments on one level was thus secured.

It is evident from the external appearance of Kedleston that the elegant centre of the south front is entirely due to Robert Adam. It was a part only of a fine and characteristic composition. Had Adam's design been carried out this front would have been complete in itself, and would have illustrated his principle of "movement," as expounded in the prefaces to his "Works."

The large original Adam drawings in the Soane Collection show that the north façade has merely been revised by him, the circular medallions under the portico being, for instance, added. Except, in fact, for a few minor details and a superior air of refinement, this front agrees with Paine's élevation.

The interior of Kedleston, however, is obviously entirely by Adam, and it is of remarkable interest, because it is a development of the work at Shardeloes, and is also closely related to the great interiors of Syon, which were in progress at the time.

Of the thought and labour that Robert Adam gave to Kedleston there is remarkable evidence. Folios of designs in colour and pencil, some of which were used, while others remain as studies, exist. Every detail was brought into the scheme, furniture, grates, fire-irons and fenders, all testify to the thoroughness and comprehensive character of his work as an architect.

The Salon, or Rotunda, into which the Great Hall leads, is remarkable for its successful proportion. It is forty-two feet in diameter and fifty-five feet high, with four alcoves in extension of each plan, each eleven feet across and twenty-two feet high. The usual size of Adam rotundas is about thirty feet.

The coffered dome is very pleasant in scale and treatment, and there is great charm in the lighting effect.

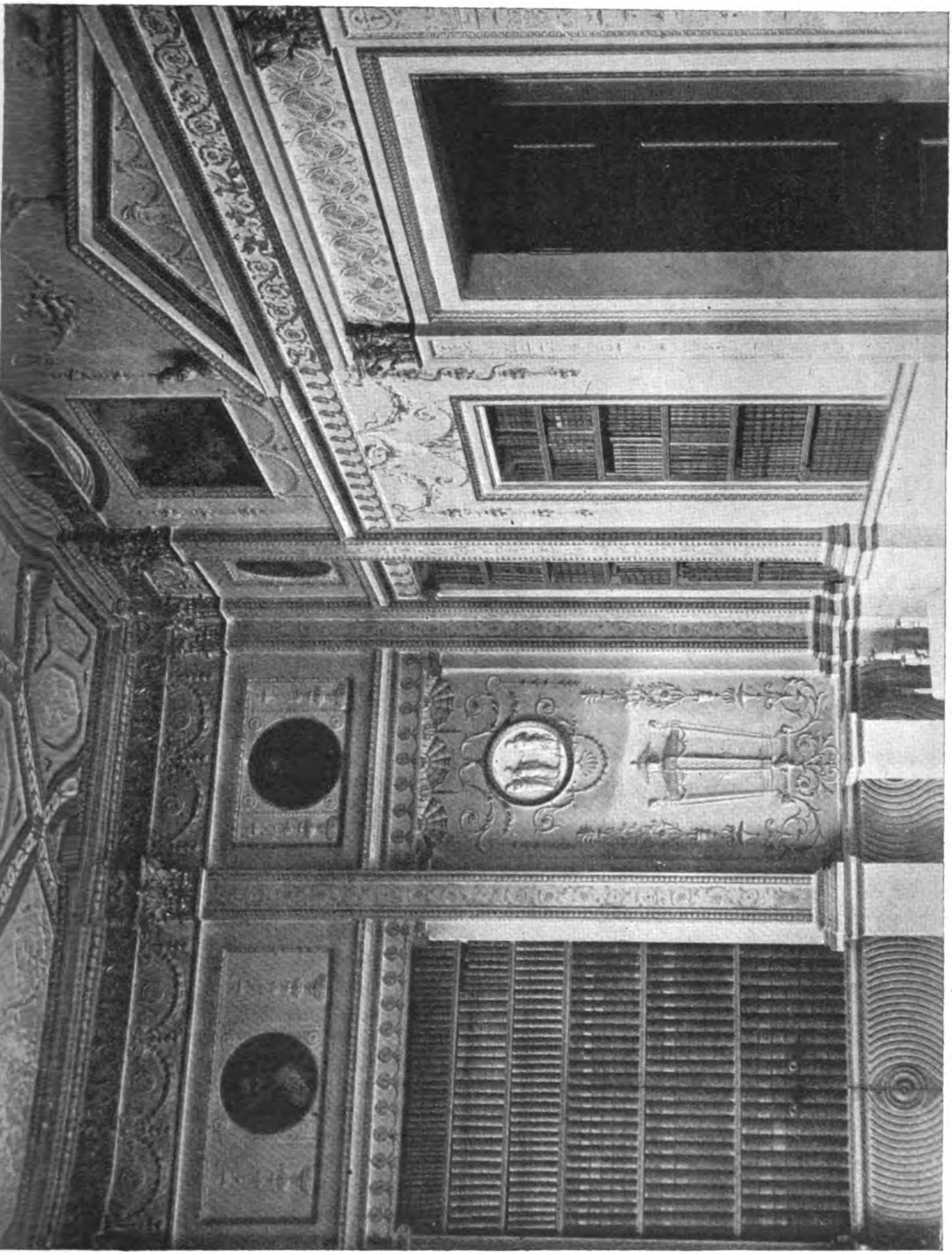
The decorative tablet panels surmounted by candelabra on the walls are notable pieces of stucco work. The minute amorini are polished to a marble surface and relieved by a dull red background and gilded frames. The striking cast metal altars, and vases in the alcoves, were connected with the hot air scheme of heating employed by the Adams in these rotundas.

The Great Hall and Salon lead on the right into the Dining Room, where Adam's attention to detail is conspicuous in the treatment of the alcove, which is flanked by two doorways of exquisite finish.

The ceiling is planned to receive landscapes by Zuccarelli and Zucchi. Other panel pictures decorate the wall.

On the left of the Hall and Salon is the music room, which contains an interesting organ case, richly gilt but simple in design. Adam's original design was far more elaborate. The white marble chimney piece is inlaid with blue-john.

The Great Drawing Room, which was originally hung with blue damask, has a coved and richly



SYON HOUSE. DETAIL IN GALLERY.

decorated ceiling. It follows closely a design dated 1760. The freedom of the decoration is reminiscent of the earlier Adam work, as at Hatchlands.

The mantelpiece, with a pair of tall figures, follows the ideal set at that house and at Croome.

The Venetian window, the columns and pediment of which, like the doorcases, are of Derbyshire alabaster, is remarkable for its scale and planning, by which an effect of great depth and richness is obtained.

The furniture of this room is of interest. Alongside of beautiful tables and mirrors, essentially typical of his style, are four massive sofas with elaborately carved and solidly gilt merfolk, mingled with dolphins and palm leaves, quite Venetian in taste, which contrast curiously with the lighter and more delicate devices for which Robert Adam was famous.

We are reminded of Adam's comment, when publishing the plate in the "Works" of the Empress Catherine's piano:—"This design was much altered by the person who executed it." Adam's drawing in the Soane Collection for the sofa, signed "R. Adam, architect, 1762," shows how the architectural limits he observed have been overpast.

Mrs. Montagu had a similar sofa, according to the note on the drawing, but with a different colouring in the upholstery, one design being red and the other green.

Her sofa, however, must have been executed in a style severely classic, so as to accord with the beautiful mantelpiece, which Adam also designed in 1766 for her house in Hill Street.

In the Library, unlike the other apartments on this floor, the Doric pillars and the entablature of the doors are in wood, and are somewhat heavy in scale and treatment. The ceiling is decorated in tints of blue, pink, and mauve. The chimney-piece agrees with Adam's drawing. The State Boudoir and its Ante-room are separated by a screen of columns and pilasters, grouped in relation to a segmental archway, late Roman in style.

In these rooms there is less of the early Georgian influence which Adam had set out to reform, and a lighter scheme of decoration and furnishing prevails.

The subsidiary buildings in the grounds and the great bridge are fine examples of Adam's treatment of accessories to his main group.

Syon House.—The plan of Syon in the "Works" bears the date 1761, which will be the time when Adam's connection with the work began. His own statement, however, gives 1762 as the year in which the Duke of Northumberland resolved to fit up the apartments "entirely in the antique style." Adam says "the idea was, to me, a favourite one, the subject great, the expense unlimited, and the Duke himself a person of extensive knowledge and correct taste in architecture."

Adam had just completed Shardeloes, and resemblances can be traced between the details employed there and those used in the earlier rooms at Syon. For instance, the ceiling of the Dining Room is closely related to that of the Library at Shardeloes.

The work must have been in progress many years, as one of the carpets is dated 1769, and the whole of the intended scheme was, even so, never realised, as the most important feature of the plan, the central rotunda, was not executed. This salon was needed to bring the entire suite to a focus and connect together all the apartments, serving, in Adam's own words, "for general rendezvous, and for public entertainments with illuminations, dancing and music." Apparently, in September, 1768, this rotunda was temporarily erected for the reception given to the King of Denmark, when 300 persons were entertained in the room, "without the least bustle."

Adam himself defines the position he had to deal with, in creating this magnificent suite of rooms at Syon within the existing walls of the house. "Some inequality in the levels on the old floors, and some want of height to the enlarged apartments were," he says, "the chief difficulties with which I had to struggle."

Entering at once the Great Hall, the full grandeur of his conception is realised. This interior, in a creamy white with a black and white marble floor, realises the classic ideal of pure form and restrained ornament.

Late in the afternoon the western sunlight strikes down from the upper range of windows, producing a wonderful effect of light and shade. The size, 60 ft. by 30 ft. by 30 ft., is about that of the great room at Wilton, but no greater contrast between the two interiors can well be imagined, and we realise at once how much has happened in the intervening century. The problem of the dimensions is solved by Robert Adam on entirely different lines to those followed by Inigo Jones. He reduces his length by a great apse at one end, and a square recess at the other, the latter having a screen of columns. The connecting walls have each five windows and a door. Such are the simple elements out of which this fine interior has been evolved.

The highly original ceiling with its large crossed

beams, doubtless arose from his wish to reduce the excessive height of the bare structure, and the idea is worked out with great skill.

A broad band of ornament frames the central oblong and ties the whole design together. The disposition of the floor follows that of the ceiling. It is doubtful if Adam ever used the Doric order, which he preferred for halls, with better effect.

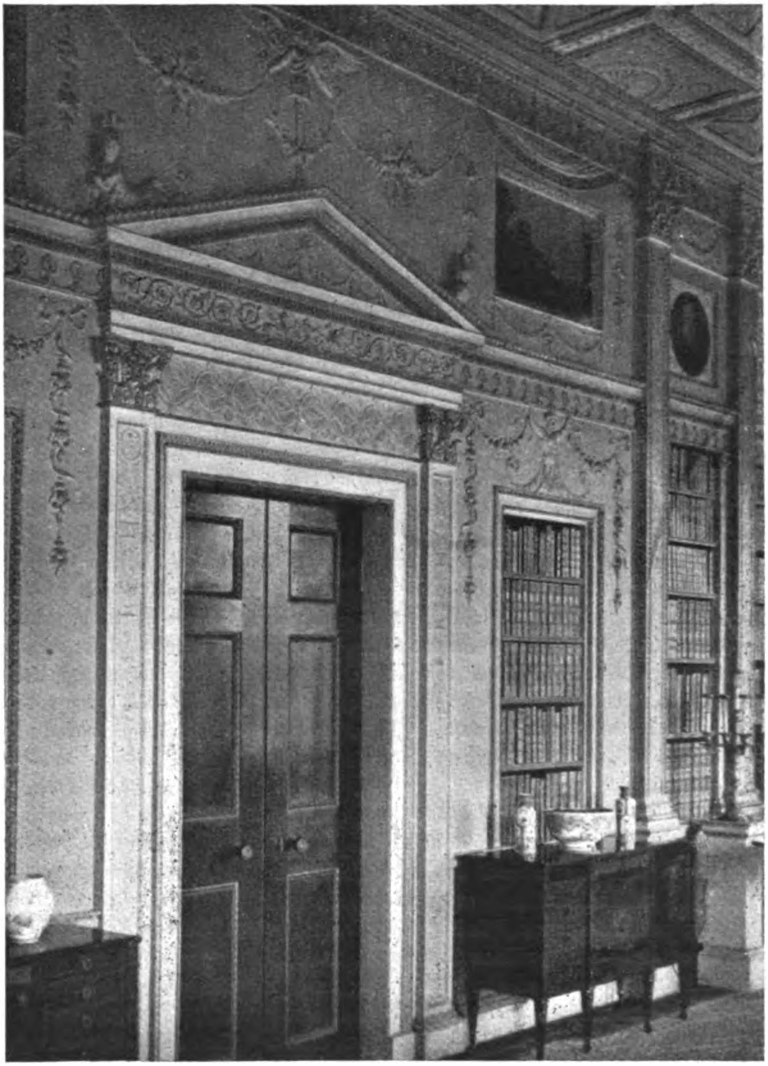
The steps, which were necessary to reach the principal floor level at both ends of the Hall, are so cleverly worked in that they seem an additional charm, rather than a difficulty overcome.

To step up from the Hall to the Anteroom is to pass into another world. It is Rome of the most lavish epoch of the Empire, when the world's wealth poured as a great river into the all-powerful metropolis. Colour reigns supreme with a predominance of solid gilding. The keynote has been twelve ancient columns of verde-antique, recovered from the bed of the Tiber. To these shafts Ionic capitals solidly gilt have been added, with a new entablature, in which the frieze is decorated with a honeysuckle in gold on a bright blue ground. The walls are pale green with doors in dark mahogany and gold. Green bronze is also used in the bas-relief over the fireplace.

The floor is a remarkable piece of scagliola, very highly polished, and marvellously preserved. The colours are yellow, bright and dark red, reaching to chocolate, and a peculiarly soft greenish grey, relieved by some actual blue.

The architectural interest of the room centres in the very clever arrangement of the twelve columns, as the room is not really square, being 36 ft. 6 in. by 30 ft., with a height of 21 ft.

The desired square set-out is obtained by bringing forward the columns on the window side



SYON HOUSE. DOOR IN GALLERY.

and carrying across the entablature, the vertical line being maintained by statues upright on the columns. Thus the room is square in effect with the minimum loss of floor space.

Entering the Dining Room we leave colour behind us and return to an effect of white, but in a warmer tone and with a free relief from gilding. This room would seem to be one of those first completed at Syon. Each end of the

room has an apse with a screen of columns across it, and the half domes are well ornamented but without the extreme beauty of those at Kenwood. A flat band carried round the room, level with the top members of the cornice of the order, connects the end and side walls, a treatment favoured by Adam.

With the Red Drawing Room colour again resumes its sway. The walls are hung with Spitalfields silk, in which the pattern of flowers and ribbons in grey shimmers like silver on a plum coloured ground. The ceiling has a deep cove, which, together with the central flat, is all set out in octagons and diamonds, rather small in scale. These have been painted with figures by Angelica Kauffmann, too small for their position, and, in addition, so emphasised by bright blue grounds, as to produce a spotty effect, which is somewhat distracting. The Adam carpet is of a good and restful design, the colours pink and yellow with some blue, all now very harmonious. It is dated "1769, T. Moore."

The two doorways are remarkable for the ivory grounds to the pilasters, which are overlaid in ormolu.

The white statuary marble mantelpiece is a masterpiece of applied ormolu. The enrichments are chased and perforated frets, appliqués, even the flutes of the columns have tiny strings of beads which are attached to the fillets between the flutes. The rosettes, swags, and even the dentils are of the same metal. It is like an overdress of gold lace thrown upon the white marble form.

This drawing room is Adam's Ante-room to the real Withdrawing, or Ladies', Room, the gallery, which he planned for their particular delight. "Furnished in a style to afford great variety and amusement," is his own expression. It is certainly a marvellous interior, because it is the Elizabethan-Jacobean gallery seen through a different medium. The problem was the narrow width of 14 ft., with a length of 136 ft., and a height the same as the width. These are quite the old dimensions for galleries in England, and it was only the orthodox classic ideas of proportion, that seemed to make them incapable of solution. Robert Adam accordingly dealt with the problem on his own lines, not, perhaps, without some observation and reflection on the many older galleries, which he must have seen in various parts of the country. His scheme is that of a unit of four pilasters, with wide intervals or bays, centred upon the three doors and two fireplaces, so that in the perspective a sense of spacing and variety is obtained, which mitigates the great extent of the gallery in length. The opposite wall, with its eleven windows, could not be made to agree with this set-out, so it has been boldly disregarded.

The pilasters, however, are retained to frame up the windows, maintain the balance of the two sides, and give the required vertical lines in the perspective of the whole.

The ceiling is daringly set out with circles, repeated down the length of the room, and held in an octagonal framework separated by squares. Unity is obtained by cross lines, which lead the eye down the vista of the gallery with a tendency to expand its width. The wide compartments in which the doors and fireplaces occur are skilfully treated with niches and circles, and the main order of pilasters is supported by a secondary Ionic, between which the bookshelves are fitted in.

The deep frieze above the architrave cornice of this minor order is varied with landscape and portrait panels, and by some circular recesses for busts and choice vases.

The minor closets and central recess are conversational retreats. The square closet is interesting, but the gem is the circular domed boudoir, which realises the setting of an eighteenth century print, of the age of Watteau, Lancret and Boucher.

The ceiling paintings of the gallery are rather small and too pretty. The general effect of the faded pink and green of the wall decorations is good. It must all have been immensely gay when new and fresh. Of Adam design there are two pairs of beautiful tables of marquetry with carved and fluted legs and framework. One of them has a scroll pattern working from two centres, so as to fill in the oblong shape of the table top. It is inlaid in yellow and green on brown. The other has an all-over pattern. They are English made. Two half-circle console tables, carved and gilt with urns worked into the base, and bearing table tops of inlaid marble, are also of Adam design, as well as two oblong console tables, the tops of which are of mosaic.

The highly-important work at Osterley, in the same locality, while partly of the same date as Syon, also contains examples of Robert Adam's later style. Space does not allow of more than a reference here, but in the forthcoming book the house will be fully illustrated and described by the special permission of the owners. Here, as at Apsley House, English execution was made a special feature. Not only does this fact dispose of the idea that Robert Adam was merely in-

debted to and dependent on Italians, but it also confirm's Soane's statement as to the beneficial effect of Adam's influence on the arts and manufactures of the time.

Luton Hoo, for the Earl of Bute (1767–8 period) must also be passed over, though it was certainly a very important transition work and possessed probably the finest of all the Adam libraries. Unfortunately this work no longer exists owing to a fire and later reconstructions.

Kenwood, Hampstead, for Robert Adam's friend and patron, the great Earl of Mansfield happily remains.

Kenwood, is a villa design created out of an older existing house. Changes, following on the death of the great Earl of Mansfield and of his architect, have altered its character externally, the removal of the main road and the abolition of the forecourt tending to give it more the character of a country-house.

The Portico, therefore, at present cannot be said to possess its original effect, while on the garden side the decay of the original stucco arabesques has led to a replastering now devoid of the ornate character of the original.

Passing through the Hall of an Adam character, a very pleasant ante-room, lit by an end Venetian window towards the south, leads into the "Adam Room," as it is now appropriately called. This truly magnificent apartment ranks high amongst the great chambers to be found in England, and takes a leading place in the list of its architect's achievements.

Robert Adam's own account is as follows:—

"The great room with its ante-room was begun by Lord Mansfield's orders in the year 1767, and was intended both for a library and a room for receiving company. The circular recesses were, therefore, fitted up for the former purpose, and the square part or body of the room made suitable to the latter." This duality of purpose corresponded with the character of the client.

"The ceiling," Adam tells us, "is in the form and style of those of the ancients. It is an imitation of a flat arch, which is extremely beautiful, and much more perfect than that which is commonly called the coved ceiling."

"The coved ceiling, which is a portion or quadrant of a circle round the room, and rising to a flat in the centre, seems to be altogether of modern invention, and admits of some elegance in the decoration."

The eighteenth century architects, following Palladio and the Italians, had established in England the lofty *piano nobile* of Italy, and had been much exercised by the excessive height so obtained, unsuited as it was for living rooms in our northern climate. The cove as described by Adam above, is found in all the houses of the time, particularly in those of single and double cube dimensions, experiments to which the Palladian School were excessively devoted.

The State Dining Room at Bowood is a good example of the coved type, and in that instance Adam has certainly invested it with "some elegance in the decoration."

The stucco work at Kenwood was by Rose, the plasterer, who was also employed by Adam at Syon, etc. "The paintings," he says, "are elegantly performed by Mr. Antonio Zucchi, a Venetian painter of great eminence; and the grounds of the *panels* and *freeses* are coloured with light tints of pink and green, so as to take off the glare of white, so common in every ceiling, till of late. This has always appeared to me so cold and unfinished, that I ventured to introduce this variety of grounds at once to relieve the ornaments, the crudeness of the white, and create a harmony between the ceiling and side walls with their hangings, pictures and other decorations."

Here we have a clear statement of Robert Adam's ideas. His ideal of low relief in schemes of house decoration, with details of elegance and refinement, carries him on to the use of flat tones of colour, which shall give the necessary emphasis to the ornament.

It is not, properly speaking, that "picking out" method which followed later, as the style degenerated in the hands of his followers and successors. That detestable method of decoration was, however, an easy step down as soon as the Adam manner was imitated and cheapened.

A main feature of the Kenwood Great Room is the pair of apses with their screens of columns, the entablatures of which, carried straight across at the spring of the half domes, bind together the whole design of the interior. By this means an effect of perspective and some mystery of light and shade are produced.

The half domes are masterly pieces of decorative stucco work, worthy of Pirro Ligorio himself. The great vault is well set out in flat compartments varied in proportion, and adorned with ovals, half ovals and circles. These are filled in with highly-coloured paintings, executed in tones strong enough to stand the rich gilding, which forms so large an element in the whole effect. The fluted columns in white are a strong element in a successful scheme.

Continuity of design between the two apses and the centre bay is promoted by a bold

honeysuckle band at the base of the vault and of the apses.

It is a recall of the narrower frieze of the entablature where lions' and bulls' heads, the family crests, are repeated in a chain of running ornament.

The two large arched recesses on either side of the fireplace had originally characteristic Adam mirrors and settees.

The bookcases of the apses had originally solid dados.

On the piers between the windows are two mirrors in carved wood and gilded frames. These are illustrated in the "Works."

The white statuary mantelpiece has carved pilasters, bulls' heads and sphinxes. Over it is the imposing portrait of the Earl, by David Martin (1736–1798), set in a panel with a finely designed flat framework. The border which balanced the top has been swallowed up by an excess in the size of the picture.

From an account of 1776 it appears that the Hall and other rooms, except the Library, had their walls covered with Indian or Chinese papers.

The *Adelphi* scheme was launched while Kenwood was in progress. It appears to have been somewhat unfortunately undertaken, and it is unlikely that Robert Adam had any conception of the drag that it was to prove upon his promising career.

The whole subject of Adam's great influence upon the architecture of London requires a volume in itself, and with regret I have concluded that it cannot be brought within the scope of these lectures. One or two leading points may be given. *Shelburne*, now *Lansdowne House*, begun about 1762 for the Earl of Bute, was sold by him to the Earl of Shelburne in 1765, and the work of completion went on until 1768. It was in the contract of sale that the house was to be completed according to the original scheme by the Adams, the vendor sharing in the expense. This house is, of course, a very important example of Adam's work.

Mansfield Street (1770), was first planned to lead up to a great house, which was not built. The houses here follow upon the Adelphi, and contain interesting work.

Portland Place, as first intended in 1773, was to have been a *corso* of great houses. When the original idea fell through, the enterprise appears to have been left to James Adam to carry out in a much less stately and magnificent manner, 1776–78. The war time delayed the scheme of the new street, and much of it was afterwards merely a continuation by Nash, or else the work of independent builders. One of the finest of Adam town houses is *No.* 20, *St. James's Square*, but even this was less magnificent in its interiors than old *Derby House*, in Grosvenor Square, which no longer exists. An example, standing in a class by itself, is *Home House*, in Portman Square, which exhibits a late phase of Adam work. In spite of alterations in the first half of the nineteenth century, this house still gives a fine idea of the golden age of late Georgian magnificence.

Fitzroy Square (1790) was only in hand at the time of Adam's death; it was stopped by the outbreak of the great war after only two sides were built. The other two, executed quite twenty years later, show the altered temper of the times.

Of the vanished *British Coffee House*, in Cockspur Street, Soane, who, of course, knew it well, spoke in his lectures to the Royal Academy, declaring that, quite as much as the Register House of Scotland, in Edinburgh, it was a monument to the ability of its architect.

The reality of Robert Adam's influence on the architecture of the time is shown by the persistent attribution to him, personally, of a variety of the buildings of his contemporaries, whose names are practically, if not entirely, forgotten.

The city of London was least affected by his revolution, the all-pervading work of Wren, and his immediate followers, constituting a strong local tradition.

In the same way the work of Robert Adam in Scotland would here make quite impossible demands on our time and space. It must suffice to call attention to the noble *Register House* of Scotland, facing the end of the North Bridge in Edinburgh, a work remarkable for the Grecian refinement of its detail, and to the later, grand and massively simple *University*, as originally designed by Robert Adam. These will all be dealt with at length in the forthcoming book.

Unfortunately the Revolutionary Wars following Robert Adam's death in 1792 blighted the fair prospects of that great work, the University, as well as those of *Charlotte Square* (1791) with its intended church.

On the resumption of both of these undertakings after the war, by the new generation that had sprung up, the Adam tradition had already been clouded over, and the resulting work fell far short of the intentions of that great

architect of the last half of the eighteenth century, Robert Adam.

[The four illustrations of Syon House are from photographs by F. R. Yerbury, Esq. The blocks are kindly lent by the Editor of the *Architectural Association Journal*. Copyright reserved.]

BRITISH EMPIRE FORESTRY CONFERENCE.

The resolutions passed at the British Empire Forestry Conference held in London in July last, and attended by upwards of forty delegates representing respectively the United Kingdom, Australia, Canada, India, Newfoundland, New Zealand, South Africa, the Crown Colonies, Egypt and the Sudan, have been issued as a White Paper, and are to be brought to the notice of the various Governments.

In view of the great importance to the Empire as a whole, as well as to each of its component parts, of producing a sustained yield of all classes of timber, and of encouraging the most economical utilisation of timber and other forest products, and of maintaining and improving climatic conditions in the interests of agriculture and water supply, the Conference affirms that each of the Governments of the Empire should lay down a definite forest policy to be administered by a properly constituted and adequate forest service.

The foundation of a stable forest policy for the Empire and for its component parts must be the collection, co-ordination, and dissemination of facts as to the existing state of the forests, and the current and prospective demands on them.

In order to attain continuity in the development of forest resources, it is desirable that certain elements of stability be secured in the constitution of the forest policy. This may be done by the following measures:—

1. The definition, where this has not been done already, of forest policy in a Forestry Act or Ordinance.

2. The reservation for the purpose of economic management and development of forest land under conditions which prevent the alienation of any which is primarily suitable for forests, except for reasons consistent with the maintenance of the forest policy as a whole.

3. The assurance to the Forest Authority of funds sufficient to carry out the accepted policy for a series of years.

4. The grant to members of the forestry service of the status of civil servants with due provision for pension.

5. The appointment as the chief officers of the forestry service of persons having a high standard of training in forestry, their selection and promotion being by merit alone.

6. The establishment in each of the larger parts of the Empire, and for the Colonies not possessing responsible government collectively, of an officer, or officers, having special duties of advising as to forest policy and surveying its execution.

It is extremely desirable that the Forest Authority should be in close touch and consultation with organisations representing the interests concerned in the extraction and utilisation of timber and other forest products.

The Conference have had their attention drawn to the advantages which have accrued in several parts of the Empire from the wide distribution of forest plants, and desire to bring the method of encouraging tree-planting by distribution of plants, either from Government or private nurseries, gratuitously or at cost price to the earnest attention of their Governments.

A scheme of research work received the approval of the Conference, and is recommended to their Governments for early consideration and approval. This takes the form of a report from a Committee dealing with the organisation and sub-division of research, with the relation of the different parts of research to one another and to education and practice, and with the subjects of research both generally and in relation to the needs of the different parts of the Empire.

It should, the Conference declares, be a primary duty of Forest Authorities throughout the Empire to establish systematic schemes of forestry education. It has been found, for climatic and other reasons, that it would not be possible for each part of the Empire to establish a complete scheme of forestry education of its own, and, therefore, it is essential that those parts of the Empire which are willing and able to establish complete systems should, as far as possible, frame such schemes with a view to combining for meeting the needs of those parts which can only themselves make a partial provision for their requirements.

Part of this subject has been dealt with by another Committee, whose report embodies the following principles:—

1. That one institution for training forest officers be established in the United Kingdom.

2. That students be selected from graduates having taken honours in pure or natural science at any recognised University.

3. That it be an integral part of the work of the institution to arrange supplementary courses at suitable centres for students requiring special qualifications, and also special courses for forest officers from any part of the Empire, whether at the institution itself or at centres of training in other parts of the world. The Governments should recognise these courses as part of the ordinary duties of the forest officer, at any time during their service, and the Governments concerned should give special facilities to forest officers in their service to attend such courses.

4. That a department of Research into the formation, tending and protection of forests, be associated with the training institution.

5. Encouragement should be given to the existing provision made by Universities and Colleges for forestry instruction for those who do not desire to take the full course suggested for the forestry service. It appears that this is especially applicable to the United Kingdom.

It is also desirable to make adequate provision for woodmen's schools for the training of foresters as distinct from those which are intended for forest officers.

The Conference also approved of the suggestions and recommendations for the constitution of an Imperial Forestry Bureau which are contained in the report of a committee. The delegates feel that it must be upon the work of such a Bureau that the proper development of the forestry resources of the Empire will largely depend, and they therefore, cannot over-emphasise its importance as a part of Empire organisation. The following questions should be referred to the Bureau immediately on its formation: (i) Standardisation of forest terminology; (ii) correct identification of timbers, and standardisation of their trade names. The total sum required will not be less than £10,000 per annum during the first five years of the Bureau's existence. It is proposed that the different Governments shall contribute on the following basis: United Kingdom, 25 per cent. of the annual expense; British India, 25 per cent.; Self-Governing Dominions, 25 per cent.; Crown Colonies and Protectorates, 25 per cent.

The delegates recommend that the next Conference be held in the year 1923, and that, if the Dominion Government approves, it be convened in Canada.

GENERAL NOTES.

Industrial Activity in Bengal.—Referring to the formation of so many new companies in Calcutta, the result of huge war and post-war profits on manufactured jute, hides, iron and steel, cotton yarn, piece-goods, paper, building materials, etc., the Calcutta correspondent of the *Morning Post* mentions that the local Stock Exchange list of miscellaneous industrial undertakings has expanded from some 30 to about 200. At the same time a large amount of new capital has gone back into the older jute and cotton enterprises. An interesting factor has been the appearance in Calcutta of certain leading English firms "driven to seek not merely new markets but new manufacturing centres for their processes by the higher costs of production at home." One London firm are in the field in the hope of exploiting India's pulp resources. Another contemplate the erection of a jam and pickle factory near Calcutta. He thinks that for the most part this industrial activity is perfectly sound. He adds:—"The resources of India, and more especially of the area which constituted the old province of Bengal, are limitless. On the west and south-west of Calcutta iron and coal exist in the same contiguity as in Lancashire, and numerous other minerals are already being exploited in that region on commercial lines. An official high in the Geological Survey assures me that, given capital, the development of the district of Singhbhum in the next thirty years should rival that of Pennsylvania or Westphalia during their great period of industrial expansion."

Industrial Research.—The British Leather Manufacturers' Research Association having been approved by the Department of Scientific and Industrial Research, as complying with the conditions laid down in the Government scheme for the encouragement of industrial research, has been granted a licence by the Board of Trade.

Eyestrain in Cinemas.—An interim report of the representative joint committee appointed by the Illuminating Engineering Society to inquire into eyestrain in cinemas forms part of the contents of a "special cinema issue" of the *Illuminating Engineer* (32, Victoria Street, S.W. 1). The inquiry originated in a request made to the Illuminating Engineering Society by the London County Council for information in regard to the possible causes of eyestrain in cinemas, and the best mode of removing them. Attention was particularly drawn to "the question of the strain to the eyes caused by the proximity of seats to the screen at cinematograph halls, and of some means of lessening the ill-effects referred to." The Committee received the co-operation of the Council of British Opthalmologists and the Physiological Society in dealing with this difficult problem, and seem to have taken great pains to make their investigation as complete as possible. They recommend (1) That the angle of elevation, subtended at the eye of any person seated in the front row, by the length of the vertical line dropped from the centre of the top edge of the picture to the horizontal plane passing through the observer's eye, shall not exceed 35°, the height of the eye above the floor-level being assumed to be 3 ft. 6 in.; (2) That provided recommendation No. 1 is complied with, the angle between the vertical plane containing the upper edge of the picture, and the vertical plane containing the observer's eye, and the remote end of the upper edge of the picture should not be less than 25°. They do not anticipate that any supplementary report which they may make will necessitate modification of the above recommendations. The representatives of the cinema industry, while approving of recommendation No. 1, draw attention to the absence of definite evidence of serious injury by eyestrain. In view of this fact, they are of the opinion that where application of this condition to existing halls would entail serious financial hardship there is no justification for its imposition. They are further of opinion that the normal development of the cinema theatre will rapidly remove all causes of possible discomfort.

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FRIDAY, SEPTEMBER 10, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

EXAMINATIONS.

The results of all stages of the examinations held from May 10th to 19th have now been sent to the centres concerned.

In the Advanced Stage 5,420 papers were worked. Of these 861 were awarded first-class certificates, 2,774 second-class certificates, and 1,785 failed.

In the Intermediate Stage the number of papers worked was 13,588, with 2,286 first-class certificates, 6,850 second-class, and 4,452 failures.

In the Elementary Stage 14,136 papers were worked. The passes numbered 9,787, and the failures 4,349.

The total number of papers worked in the March and May examinations this year is 49,390, against 31,132 in 1919. Of the former 7,062 were in the Advanced Stage, 1,098 first-class and 3,430 second-class certificates being awarded. The number of failures was 2,534.

In the Intermediate Stage 18,696 papers were worked. The first-class certificates numbered 2,964, the second-class 9,499, and the failures 6,233.

In the Elementary Stage the number of papers worked was 23,632. Of these 15,890 passed, and 7,742 failed.

In 1921 the first, or Easter, examination will commence on Monday, March 14th, and finish on Wednesday, March 23rd. The second, or Whitsuntide, examination will begin on Monday, May 2nd, and end on Wednesday, May 11th. The syllabus for 1921 will be published shortly.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

THE ARCHITECTURE AND DECORATION OF ROBERT ADAM AND SIR JOHN SOANE, R.A. (1758–1837).

By ARTHUR T. BOLTON, F.S.A., F.R.I.B.A.,
Curator of Sir John Soane's Museum.

Lecture III.—Delivered May 17th, 1920.

If architecture is to be seriously regarded as a reflection and record of the life in all its varied aspects of any particular period, then we must expect to find that Sir John Soane, however great an admirer he may have been of the architectural genius of his own early days in London, would yet, in his own subsequent work, achieve an artistic effect very different in character to that realised with such success by Robert Adam.

Much had happened since the climax of the late Georgian prosperity and magnificence, coincident with the mid-point of Robert Adam's career as a practising architect in London, a date which may be taken as almost that of Soane's first great success, the winning of the gold medal of the Royal Academy in 1776.

The disastrous American War, the domestic troubles of the Gordon Riots, the collapse of the King's system of personal Government through Lord North's Ministry (1770–1782), were only premonitory symptoms of the great avalanche of the Revolutionary Wars (1793–1815) which overwhelmed the existing social order in Central Europe, and profoundly modified that of our own country.

Robert Adam's own work, in his last years, when under Pitt's guidance the country appeared to be recovering its prosperity, seems to have assumed a graver cast.

By a curious inversion a greater parade of architecture is demanded on the exterior of the houses, a more distinctive assertion of the class rather than of the individual, and the interiors tend to lose their former importance. A more equal standard of decoration, a type in fact is being established for a majority, to which each individual will more or less be driven to conform.

Unlike Robert Adam, who was never recognised, young Soane was a chosen pupil of the Royal Academy. Sir William Chambers, founder and protector of the infant institution, had approved of his Triumphal Bridge, and had himself introduced the successful student to the Royal Patron, as a preliminary to his start upon his grand tour.

Chambers was incapable of change. In his last edition (1791) of the "Civil Architecture" of 1759 he reiterates his earlier condemnation

of Greek architecture. The work of Adam and Stuart was unchaste, subversive of true principles, and students and the public must be protected, on principle, from its pernicious influence. This frame of mind is a recurrent phenomenon, and there is no particular way of dealing with it, other than that of maintaining a sound tradition of artistic liberty and equality, if not of fraternity.

It is to Soane's credit that his individuality was strong enough to withstand this pressure. As a pupil of George Dance, R.A., he had been in touch with a gifted designer, whose trend was towards experimental essays, and new combinations. Unfortunately, Dance was weak on the constructive side, as well as somewhat lacking in energy. He seems to have admired the force and determination of his pupil. "Remember," he writes to Soane, "your motto *Mihi turpe relinqui*," while at another time he cautioned him to "sprinkle cool patience upon the heat of thy distemper."

Henry Holland, jun., to whom Soane appears to have been an assistant from 1772 to 1776 or 1777, was also an architect of rare ability, and a man of a modest and retiring nature. His earlier work is like that of Robert Adam and James Wyatt, but in the interiors of Carlton Palace he seems to have struck a note more definitely Græco-Roman, for which "Empire" is, perhaps, as nearly an equivalent term as any.

Soane's association in his Roman days with the Bishop of Derry, afterwards first Marquess of Bristol, seems to have brought him into touch with a learned society imbued with the classics. He makes designs for a "dining room" and a "canine residence" in the antique manner, but follows it up by modern versions of the same. This is very characteristic of Soane's practical habit of mind.

He studies the "antique," but as an artist who is in search of material for the development of his own powers and the realisation of his own ideals. A merely dilettante attitude was alien to his temperament. This is revealed in his attitude to a draughtsman, who showed him the usual sketches of the Pantheon portico at Rome. "Are the columns equally spaced," he inquires, and when the sketcher hesitates, a curt "Ah, I see you do not know!" closes the discussion. He himself had measured the Pantheon, and the bearing of the facts had not been lost upon him.

The effect of Soane's grand tour upon his mind appears to have been that of modifying his first love of Adam and Wyatt work, through the deep impression made upon him by the Greek Doric of Pæstum and Sicily. As is well known, he was prevented by circumstances from reaching Athens, and seeing the masterpieces of the Doric and Ionic styles in all their effectiveness. The Street of Tombs at Pompeii also, I fancy, profoundly impressed him.

The consequence was that when Soane began to rebuild the Bank in 1794, he treated its screen-wall decorative architecture on lines which were profoundly original. The new work was something entirely different from that which might have been predicted from a pupil of the designer of Newgate, and of a student who had come so directly under the influence of Chambers.

The interior of the Bank especially is remarkable because, although there is an apparent following of the scheme of the Roman thermæ, the character of the design is entirely novel. It is more modern than much that is projected or executed to-day. Soane's feeling for the bones of the architectural corpus is almost uncanny. The Bank interiors are as remarkable in that way as the much later work of Duc in the Palais de Justice at Paris.

When allowance has been made for the temper of Soane's age, as one of war with all its revulsions and ensuing exhaustion, his work holds good as an astonishing reversion to the bare realities of design, after the magnificence of Adam decoration and ornament.

Soane possessed a great feeling for surfaces, and his linear method of decoration perhaps arises from that source, as though he would abolish all projections, lest any shadows or excrescences might detract from their effectiveness. At the same time these considerations must not be pushed too far, as though Soane was wedded to a clearly-defined and closely-reasoned logic. He never was a clear thinker; on the contrary, he is given to flashes, often strangely phrased, which burst through an ultra dry form of verbal expression. Only when he is roused does Soane break through this acquired reserve, and even then there is a certain cloudiness, witnessed by phrases like the "poetry of architecture," to be achieved apparently by the union of forms and qualities usually regarded as antagonistic. It is easy to understand, therefore, that the attitude of his contemporaries was one of bewilderment, not unmixed with ridicule.

George Wightwick truly reports that no architect was ever less beholden to his own time, nor anyone more crudely assailed. It would have been too much to expect that the

essential quality of Soane's art should be generally appreciated in his own time. Even to-day it arouses questionings as to method after the general harmony of the whole has been admitted.

It is not pretended that Soane as an architect ranks with a master like Robert Adam. He is always a pioneer pointing towards something, which, perhaps, is incapable of being realised, and hampering himself by difficulties of expression never completely mastered.

For one thing Soane's design is extraordinarily fluid; he multiplies alternatives to an extent which produces absolute confusion, when the building, to which all these drawings, apparently finally, refer, is no longer in existence.

Worst of all Soane is apt to repeat forms already used by himself elsewhere, as though he had himself grown weary of his own vacillation.

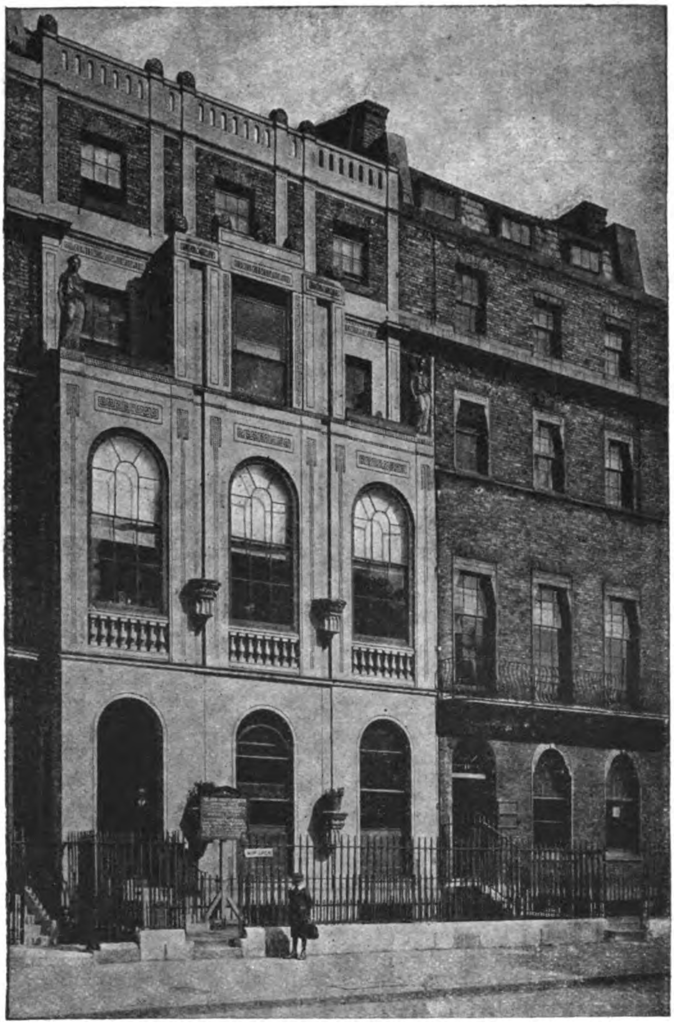
This uncertainty of temper probably accounts for the ridiculous importance that he attached to Père Laugier's architectural dogmas, as set forth in the "Essai sur Architecture" of 1755. This amateurish effort owed its passing importance to the circumstances of the time in France.

A tide of revolt had set in against the license of the Jesuit style, and the worthy Father, intent upon his intended reformation, propounded a short cut to purity by a drastic amputation of the body of architecture. There were to be no more pilasters, arcades, and high basements, no domes or other exuberances; all was to be reduced to the pure Order of Columns of the antique pattern.

There was, however, this anomaly, that in the desert was to bloom a new flower, a triangular church with three apses, at once mystical and correct. Soane seems to have taken all this quite seriously, and the implied dogmas were a fatal handicap to his monumental designs on several occasions.

An important incident, that can only be lightly touched upon here, was the check to Soane's artistic development, arising out of the fatal outbreak of the great wars in 1793.

Had his new House of Lords design, approved in 1794–6, proceeded, as in times of peace it certainly would have done, Soane would, by the test of the execution of his ideas on an adequate scale, have risen to a much higher rank as an architect, and gained a more effective influence on the art of his own, and probably of subsequent times. The problem of this design

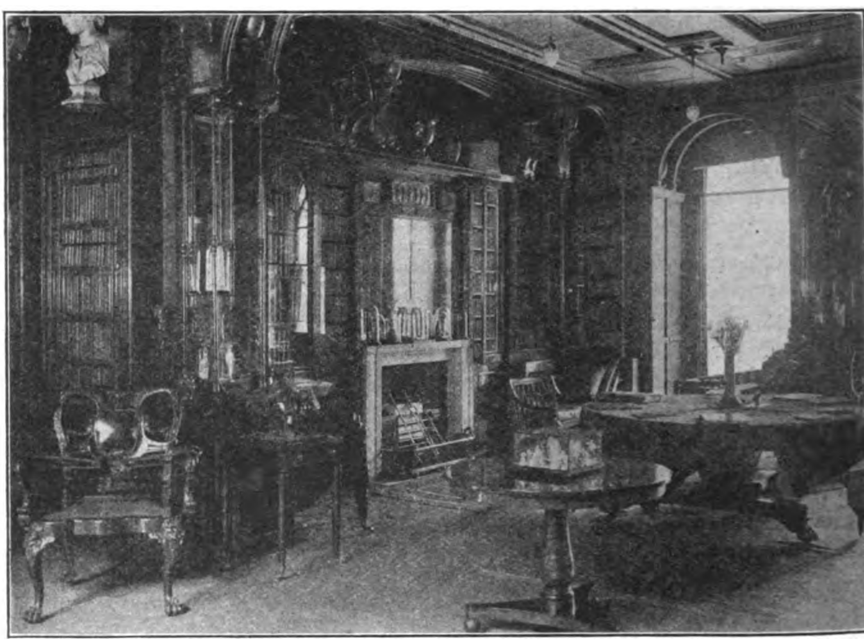


Sir John Soane's House and Museum, No. 13, Lincoln's Inn Fields.
Built in 1812. House on the right, 1824.
Similar house on left, 1792, Soane's first house in the Fields.

could only, with a man of his temperament, be solved by the clamorous exigencies of the actual work. He played with it for the remainder of his life, without ever being pinned down to a definite and convincing result.

The effect that a great range of state apartments in a national building, like the Houses of Parliament, would have produced in his hands can be judged in part only from the interiors of the Bank. Masterly as these are, they have always been too disjointed by business necessities, and too difficult of access, to have produced the culminating effect promised by the abandoned scheme.

the actual work executed by Soane in 1823 at the old Houses of Parliament, the famous Scala Regia, we have only the drawings and some contemporary report. It was day and night work, having been rushed through in seven months in order to gratify the impatience of George IV. That it was a fine design, we have the drawings of artists made at the time to show, and the only serious criticism seems to have been that it was, as usual, deficient in scale to realise the full effect. It is also possible that this interior was not so reticent in detail as the rest of Soane's work, but, when his buildings have disappeared, it is unsafe to express an opinion on this head,



Sir John Soane's House, No. 13, Lincoln's Inn Fields.
The Library on the Ground Floor Front.

Soane's buildings after the crisis of the war are manifestly crippled by a smallness of scale and means, inadequate for the real grandeur of the design. Dulwich Gallery and Mausoleum, for instance, do not, as built, possess the impressiveness of which Soane's design was capable.

Deprived of this quality, his architectural design is apt to be regarded as mean and ugly, by those who fail to appreciate the method of the artist, and to remember that "the best of this kind are but shadows, and the worst no worse, if imagination do but mend them."

It is against the critics that they could see this in Gandy's interpretations of Soanic design, and endeavoured to set the one against the other. Of

as experience of the effect of the Soane interiors made upon varying spectators will soon demonstrate.

The writer recalls his own impression of many years ago of the interior of the old Law Courts at Westminster, probably the first Soane work he ever saw. The earliest sight was bewildering; it was like something never seen before. It defied criticism in detail, possessing a harmony of its own which called for complete acceptance, or rejection, on the part of the spectator.

This fact naturally accounts for the hostility of opinion that followed Soane in his career, as closely as the great admiration of those who felt that he was undoubtedly possessed of genius.

It must be, therefore, worth while for the student to consider with some attention the theory and practice of an architect possessed of so much force of character.

One source of Soane's ideas seems to have been his own study of the antique mausoleums to which Robert Adam had called attention. In the endeavour to determine the true character of the private domestic architecture of the Greeks and Romans, as distinct from that of their temples, it was only natural that reliance should be placed upon those scanty remains of antique fresco decorations, that possessed backgrounds of an architectural character.

The argument may be stated as a proposition that painters do not in fact design, in the architectural sense, but simply recall what they have seen, and are familiar with, in the forms of the buildings around them.

Even Fergusson argues in favour of a metallic architecture in the ancient world. The bronzes of Pompeii and Herculaneum, moreover, show the design that was lavished upon candelabra and tripods, a care which may very well have been extended to those features of domestic interiors for which metal could be used. It is quite possible that woodwork was treated in a metallic sense, where bronze or iron could not be afforded.

It is certain that the design of the library of the Soane is derived from hints of this character, and that there is a deliberate attempt to realise the flying arches, and other features, hinted at, in the backgrounds of antique frescoes. In the miniature loggia of the first-floor front we have a much later attempt to realise some Roman gallery, as it might have existed in an imperial palace, or large villa. Colonnettes of metal are reproduced in wood, decorated as green bronze, in conjunction with busts resting on metal-like architraves. Candelabra, medallions and bas-reliefs are brought in as elements in the scheme. The extraordinary complexity of the remains of the Villa of Hadrian, at Tivoli, suffices to show how wide a range of domestic work must have existed in Antiquity. This particular example, moreover, was probably not considered, by the architects of the period, as much more than the extravagance of an imperial amateur. We have, therefore, little more than a hazy idea of the work of the great architects of the old world of Greece and Rome, in the domestic sphere. It is as though the Vatican had perished, and we had merely St. Peter's as a witness to the age of Bramante, Peruzzi, Pi·ro Ligorio and Raphael.

Sir John Soane's House, No. 13, Lincoln's Inn Fields.
The Breakfast Parlour.

The building of Pitzhanger Manor in 1800–2 affords a useful clue to the line of development of Soane's domestic interiors.

Previous to this work he may be said to have worked in an attenuated version of the Adam style. The interiors of No. 18, New Cavendish Street, which he fitted up for the Earl of Hardwicke, are a case in point. It is not certain that the fine-drawn ceiling on the front first-

floor drawing room is his, but it is very probable. Here we see work of a Wyatt-Adam character.

In contradistinction to Robert Adam, Soane was not a unique master in the special field of house-building. His work is always interesting and full of ideas, but there is an architectural *parti pris*, which hampers the full and free expression of its domestic character. It calls to mind a saying, which may perhaps be traced back to Norman Shaw, or Nesfield, that what the student requires is to eliminate *the architecture* from his house design.

Pitzhanger is interesting as an architect's house, a classical villa essay. Soane was thinking of a "house for an architect in the antique manner." Horace Walpole tells us that he suggested that "the Gallery of Syon should be fitted up in the manner of an antique columbarium," about the last idea that it excites in Robert Adam's hands. Soane's largest and most important house was Tyringham, in Bucks. There is a fine reserve about the exterior. It illustrates what he was intending for the new House of Lords, a design in hand at the same time.

The hall vestibule was practically one bay of one of the large halls of that design. The centre of the house was sacrificed to a lanterned structure, or "tribune," of the type which Soane realised more effectively in the Pitt Cenotaph, at the National Debt Redemption Office, in 1818. The architect was thoroughly pleased with the house, and George Dance both admired it and proposed to "steal from it." It certainly had dignity and character, but as an English home it left a great deal to be desired.

Unfortunately Soane did not build his design for Butterton, in Staffordshire (1816). This is an Adamitic-Greek design, rather suggestive of a medium sized museum or town hall. The interiors, following on his experience with his own house in Lincoln's Inn Fields (1812), would have been of great interest, as an illustration of the further development of his ideas of interior decoration. When Soane built for himself he had always his collections to house and exhibit, and, therefore, it is difficult to judge what he might have done, when free of such considerations.

Bank of England. Sir John Soane, R.A., Architect.
The first part built 1792–6. Eastern end of façade to Threadneedle Street.

The circumstances of the time must be recalled. Even the painter Lawrence filled his rooms with casts of statues and Greek architectural details. In 1830 Barry puts a cast of the Parthenon Frieze round one of the interiors of the Travellers' Club, and in the Reform (1837) there is a relic of the same idea in the smoking room. The younger architect was emancipating himself, and the interiors of the Reform Club as a whole marked a new departure.

Decimus Burton, in Grove House, makes his circular hall like the lantern of Demosthenes turned inside out. If this is recalled as an outline sketch of the ideas of the time, the merit of

Soane's interiors in his own house in Lincoln's Inn Fields will be better appreciated.

Pitzhanger illustrates in its interior how far Soane had lost touch with the Adam scheme of decoration, because, although he refers to the two rooms there by his master, Dance, which he was preserving, as "exquisite," he makes no attempt to follow the same style. Admittedly the main feature of the exterior recalls his admiration of the Adam centre-piece of the south front of Kedleston, but his own new interiors were purely Soanic.

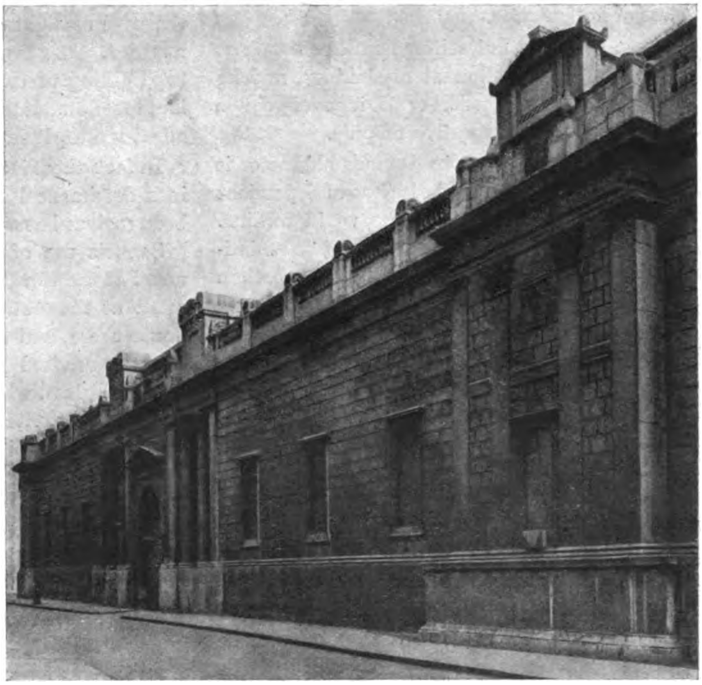
As compared with No. 13, Lincoln's Inn Fields, of ten years later, the Pitzhanger interiors retain too much of the mausoleum character.

The most symptomatic room is the front parlour, which contains the germ of the famous breakfast parlour of the Soane Museum. The differences, however, are remarkable. In the later work, apart from the structural novelty of the lighting, by which the earlier dome-vault becomes a canopy with two sides clear of the walls, the elimination of the caryatid element of the earlier design shows a much greater appreciation of domestic character.

The Pitzhanger parlour had a marble effect, while that of the Soane is suggestive of wood. Taken as a whole, the tendency of his design is in the direction of an omission of all projecting features. Everything becomes flush, and all the usual details of skirting, chair rail, architrave, and cornice are boldly dispensed with. Even the door panels are made flush, and inlays, or reed flutings, replace the customary sunk and moulded surfaces.

A little later Soane was attracted by the possibilities of mirror glass for the reduction of shadows, and the illumination of blank surfaces. I do not think that his idea was at all that, which later on became such an abuse, the endeavour to multiply interiors by the use of large sheets of the reflecting surface of mirror glass. Where a comparatively long piece of unbroken mirror is used, over the bookcases on the west wall of the library, a special effect was arrived at, that of giving clearance to the flying arches, and of repeating the horizontal plane of the ceiling with its compartments. It is a special case, which is justified by its surroundings and undeniable effectiveness. Soane makes a further use of spherical mirrors in order to focus certain interior views. These are decoratively distributed in panels forming part of the internal design.

Splayed jambs to windows, or archways, are also sometimes panelled with mirrors, with a view to the better distribution of the light. When Soane calls attention to the compartments of the ceiling of his house, he connects them in idea with the main lines of the floor construction above. This shows that he wished to avail himself of the depth provided by the old system of girder-beams, binders, and double floor and ceiling joists. Inside this framework he devises panels with spherical surfaces, an outcome of his exceptional knowledge of domical and vaulting problems.



Bank of England. Sir John Soane, R.A., Architect.
East Half of Back Elevation.

From a curious memoranda, preserved by one of his travelling companions, it would appear that such problems had been thoroughly explored in his early days.

The type of cross vault, that is seen at Pitzhanger and in the Soane Museum, is one that occurs in Southern Italy. It is a method of eliminating the groin by the use of a flat surface, forming, as it were, a gusset. There are thus two intersections instead of one. I believe that this system, which I have seen in process of building on the eastern coast of South Italy, arose to a large extent from the need of dispensing with centering, as the masons seem able to carry out these vaults on practically a self-supporting basis. Soane, at the Bank, had already displayed great ingenuity in constructing his segmental and other vaults, and domes, by means of hollow pots.

Where he uses a flat ceiling he often dispenses with all but the shallowest of sinkings, and he relies on lines of reeds, or strings of single beads, rather too suggestive of pills.

Another form of a more dubious character is the Soanic pendant, a kind of frieze of dependent drops, like reversed cones, concave in outline. Probably this arose out of an attempt to assimilate features of a Tudor and Elizabethan character.

If justification for these divergencies is needed, it may be found in the proposition that constructional features in architecture tend to pass into forms of decoration, and that the use of such features is governed only by the artistic instinct of the architect.

The attempt to apply the logic of ethics has always involved contradictions of theory and practice, visible enough to all but the convinced partisan. Whatever the theory that may be put forth as an infallible guide in architecture and decoration, it is surely obvious that it must be applicable to all styles alike, and be true of the most ancient, as well as the most modern masterpieces.

When Soane deals with colour in internal decoration he proceeds on lines quite opposed to those of Robert Adam. In the interiors of his own house he depends on the natural colours of the wood and marble, either actual or in paint, with the relief derived from metals, and metallic colours, like bronze. He then obtains emphasis by masses or bands of bright positive colours, *i.e.*, bright Venetian, or Pompeiian, reds, and yellows, primrose, or golden, in hue.

Although Soane uses polished brass, in connection with woodwork of mahogany inlaid with ebony, as in cappings and inserted colonnettes, he does not seem to have indulged in gilding, which is remarkable, when we remember the common form of the white and gold interiors of his own period.

In the course of time the original colours of the drawing rooms and the staircase at the Soane have been lost sight of, and green has been introduced with an effect quite un-Soanic.

Probably the interior of the museum itself was in stone colour, because here Soane was relying on the vivid hues of the stained glass in his lanterns. Red, purple, blue, and varying shades of yellow, were employed with a double motive, firstly, to modify the light, in which the marbles and casts were seen, and, secondly, to obtain flashes and local spots of vivid colour, through the rays of light passing through his coloured margins. The large use that Soane makes of top lighting, preferably through lanterns, enabled him to follow out these ideas, because the powerful effect of a top light removed any fear of obscurity.

In fact, there is now an excess of light, resulting in a detrimental glare, where his lanterns have been reglazed at any later time with clear glass.

Soane's use of coloured glass was certainly novel at the time, because gibes were frequently made at the "stained glass dome" in his own house there, and at the new Law Courts (1824). He was advised by his friends to take out the coloured glass, which he had put in, in view of the ridicule excited by its novelty.

In Soane's bands of brightly coloured glass, roundels or guilloches, etc., were etched out in white, probably by an acid, and then shaded, with a scratched high light. Unaltered houses of his period, and up to say 1840, will often be found with these margins of coloured glass, before the general revival of leaded glass. There is one important distinction in Soane's use of yellow glass to diffuse an effect of sunlight, which arises from the fact that some of the glass is white, while the colours have a considerable range in tints from light to dark. I do not think this was merely an inequality of manufacture in the glass, but that it was deliberate on his part, and the resulting effect is quite different to that produced by a needless uniformity of tone, as may be seen in the mausoleum at Dulwich, which must surely have been reglazed at some later time.

It would not appear that in respect of the painter's art, Soane drew any marked distinction between easel pictures, and paintings deliberately decorative. The "History" School of the period, that of West, Northcote, Hilton and Haydon, was regarded at the time as a British achievement, which it was a patriotic duty to patronise and support. If Soane's earnest desire, to have placed two paintings of this character

in large panels on the walls of his Scala Regia had been fulfilled, it is to be feared that the decorative result would have been small, while as pictures they would have been no better than the canvases of Durno, Howard, and Jones now in the Soane.

It is probable that Soane, during his time in Rome and Italy, was too exclusively devoted to an absorbing study of architecture, and architectural design, to be able at a later period of his life to free himself from the current ideas of his own day. Although a personal friend of Turner, his choice of the three works by that master, now in the museum, shows no instinctive grasp of the real tendency of that great painter's revolution in art. It is also remarkable that Gainsborough, David Cox, and Constable are not represented at all in the Soane.

In the ceiling of the Soane library and dining room, the paintings by Henry Howard, R.A., inserted as late as 1834, are decoratively less effective than the purely architectural panels, and the ceilings of the two drawing rooms above would gain little by painting. The earlier ceiling of 1792, at No. 12, had a trellis-painted decoration, but Soane did not repeat the experiment.

The Privy Council Chamber ceiling (1824) shows no hint of any such decoration.

It might even be argued that Soane in his pictorial decorative essays was merely acting under the impression produced by Haydon's active campaign, which eventually led up to the Westminster Cartoon Competition, and its not very fortunate outcome, the frescoes of the new Houses of Parliament.

There were considerable limitations in Soane's theoretical endeavour to unite sculpture with architecture. In the most typical Soanic work sculpture plays a very minor part, if not entirely absent. One or two rather wild designs on paper show an excess of caryatid figures, that would have been better entirely omitted. At his best, when he was employing Banks, the sculpture provided at the Bank is only a pair of roundels, of the type used in the Roman triumphal arches, and some suggested figures on the skyline, as in Palladio.

Some cherubs in pendentives, or in the dies of pedestals, are similarly limited examples of its use. He had a passing idea of inserting a series of bust-like heads, between the trusses of the large Italian cornice of the State Paper Office, but was fortunately persuaded to omit them.

Bank of England. Sir John Soane, R.A., Architect.
Angle to Lothbury and Princes Street. (1805–8.)

As good an instance, as any, of Soane's use of sculpture were the caryatid figures on the staircase of the Marquess of Buckingham's house, in Pall Mall, (now pulled down).

At the same time Soane most certainly appreciated Flaxman, and secured some of his best models. He also collected Wedgwoods by Tassie and Webber. Thanks to him also we have the four fine eagle panels from Carlton Palace, the work of his former chief, Henry Holland, junr. It might very plausibly be argued that Soane's most interesting and characteristic

work is purely architectural, and dispenses with both painting and sculpture, for instance, the Tivoli Corner of the Bank, the Loggia of the Governor's Court, the Vestibule Entrance from Prince's Street, and the façade of his own house. In the last instance the two isolated figures are not essentials of the design.

Soane's attitude to the decorative arts was inconsistent. He actually apologises for Robert Adam's attention to decorative details, on the ground that William Kent had done the same! This false attitude may be regarded as an outcome of Reynolds's "high art" doctrines, and the absurd isolation of "History" painting as a supreme emanation of art. It is allied to Chantrey's later neglect of detail, as of something opposed to the purity and grandeur of classic sculpture, etc. The fact is, of course, that very erroneous views prevailed as to the practice and theory of the Greeks. Even Flaxman in his lectures displays a curiously limited appreciation of the art of the Early Renaissance period, and an absolute indifference to its later developments.

The touch that Robert Adam alone had established with these schools disappeared in the course of the Greek Revival. Not until the appearance of Alfred Stevens did the decorative aspect of sculpture, in relation to architecture, obtain a fresh recognition in England.

The unique aspect of Soane's work, its peculiar harmony in itself, and freedom from vulgarity, can best be appreciated perhaps by a comparison with such contemporary work as the long gallery at York House (now the London Museum), and at Apsley House, the Waterloo Gallery, all interiors by James Wyatt's sons. The Buckingham Palace interiors, also, the work of John Nash (1827), illustrate the poverty-stricken condition of the contemporary design of interiors, and the steep descent from the high level of the Adam period.

Some interior work by Decimus Burton is alone comparable with Soane's, until we come to the work of Barry and Cockerell. In the case of the latter his early work at the Bank compares unfavourably with that of Soane. C. H. Tatham writes in 1833 to Soane of some early work, probably at the Bank, by young Cockerell, as to the identification of which I am uncertain:—"Exteriore cattivo! Interiore peggio!"

The interior of the Hanover Chapel in Regent Street (now pulled down) was much below the exterior in refinement and effectiveness.

The old Debtors' Court in Portugal Street was a good instance of Soane's power of producing a fine interior out of very simple constructive elements. From the drawings and photographs, which are all that remain, it is clear that this square interior, with four large semi-circular arches, carrying a flat ceiling, possessed a great deal of character. There was also a kitchen under the state room added to Freemasons' Hall, which appears to have had a similar effectiveness. It might have been anticipated that the National Church Building Movement of 1818 would have produced something of the effect of the earlier essay, in the reigns of Queen Anne and George I.

Soane, who was consulted in the company of Nash and Smirke, did his best to secure adequate results, but his Report, urging an allowance of £30,000 for the larger churches, was fatally disregarded for an absolute limit of £20,000. Soane's best design for Marylebone was consequently shut out, and from the two or three examples, which he did carry out, it is only too evident that he had lost any vital interest in the matter.

The rejected design, preserved in a good model, is one of very great interest. It is an arcuated structure with a continuous vault having openings that serve the purpose of a clerestory. The tall moulded round arches and piers have no imposts, and the subordinate gallery is well contrived, without any break in the main lines of the interior. A bold segment arch of the full width of the church marks off the chancel. The whole structure has more sympathy with the early Romanesque, than with any phase of the succeeding Gothic. It was an experimental design that deserved to be executed, and might have proved fruitful. Certainly it was far in advance of the generality of the churches built out of the million grant.

In conclusion, it may be pointed out that this brief survey, in touching on the Architecture and Decoration of Robert Adam and John Soane, has extended over three-quarters of a century.

At the outset Palladianism was in the ascendant, challenged only by French and Chinese tendencies, as well as by the opening buds of the coming Gothic, and Greek, Revivals. At the close of the period all that was left of Palladian tradition was in process of being transformed by the Astylar Italian, introduced by Sir Charles Barry, who was breaking away from his early adherence to Grecian Revivalism.

Mediævalism had grown into a formidable movement, and the generation immediately following upon Soane's death in 1837, was to witness both the high-water mark and the ebb of that movement.

The veteran of eighty-four was perhaps the last of those who could put in any claim to the friendship of Robert Adam, and with a prophetic instinct he had secured the great possession of the remaining original drawings of the master, at a time when Robert Adam's work and reputation were under a deep, if passing, cloud.

As Sir John Soane's pupils died off appreciation of what he had achieved declined. His great collections were valued for other things than those upon which his own heart had been set. His house came to be regarded as the expression of an eccentric, a monument of personal vanity, and his work as anything but a serious contribution to architectural thought.

The destruction of Soane's buildings has been very extensive, and it is fortunate that his tree was too deeply planted to be entirely rooted up.

It is singular that one of the most discerning tributes to his work should have come from George Wightwick, temporarily in his employ as a private secretary, who left him in a rage after some three months' service in 1824. This personal contact, however, mellowed by the experience of professional life on his own account, and by the passage of time, left a deep impression on the younger man, which is finely expressed in his "Palace of Architecture."

Probably few to-day would care to assail the position of Robert Adam, as a revolutionary artist whose work has left a permanent trace in the history of Architecture.

Sir John Soane's contribution to architectural thought may be challenged, and only the future can show the quality of the wheat as distinct from the tares, which are so easily detected and dwelt upon. That there is a continuous thread running through the whole of architectural history seems self-evident. Each generation essays its own problems in a different spirit, but the tradition is always present, and the task of assigning relative values to the individual contributors is not one to be lightly essayed.

It is sufficient to claim for Soane the possession of original ideas and a power of expression, which makes his buildings so distinctively his own.

Invited to address you here in a House, erected for your Society by Robert and James Adam in 1772–4, I have had the privilege of speaking before a Society, which was nominated by Sir John Soane himself as an elector of a Representative Trustee of the Sir John Soane Museum, being myself its Curator.

It only remains for me to thank you most sincerely for the privilege, and to express my sense of the kindness of the attention which has been given to my subject.

Epilogue.

On the occasion of the third Lecture, in view of certain rumours in the Press, the foregoing was not delivered as printed, as it was thought that the minds of the audience would be occupied with the Bank. Occasion was, therefore, taken to point out the value and importance in the history of English Architecture of Sir John Soane's masterpiece. As, however, an account, fully illustrated, will, it is hoped, shortly be given of this and others of his buildings, in a separate "Publication of the Sir John Soane Museum," it would be superfluous to print here what was actually said on the occasion of the third Lecture. Three special photographs which were taken to make slides for this lecture are, however, reproduced. The first of these shows the earliest part (1794–6) of Soane's rebuilding of the Bank, this right-hand wing being subsequently repeated in 1823, when the left-hand wing of the Bank was rebuilt, as the later portion of the work. The centre block, not shown, is a recasing of the original Bank building, of which Sampson was the architect. The second illustration shows the first half of the North, or back façade, of the Bank. As, owing to the street improvements of 1800, it became necessary to double this frontage, Soane desired to build a great hexastyle portico, as the centre feature of this newly-extended façade. The necessary projection into the street being, however, refused, Soane was obliged to content himself with the narrow-bay design, seen on the right-hand side of the photograph, which as a centre he always felt was inadequate. The third photograph shows the masterly angle feature of the north-west corner of the Bank at the junction of the two streets. This unaltered work gives the full effect of Soane's unique design, and it has always been regarded as his masterpiece. The design is given in relief on the reverse side of the gold medal presented to him in 1834 by the architects of England.

[The six illustrations of Sir John Soane's work are from blocks kindly lent by the Trustees of Sir John Soane's Museum. Copyright reserved.]

MEDICINAL PLANTS IN BAHIA.

The State of Bahia (Brazil) offers to the medical world an abundant and varied supply of plants, roots, barks, and gums, including many of recognised value, and some regular articles of export such as ipecacuanha root, araroba powder, jaborandi eaves, and Jatobi gum. Most of the plants exist in practically inexhaustible quantities, but orders

must be placed in advance with local exporters, for there is no regular trade even in those articles now appearing among the State's exports. The supply depends entirely upon the demand. The following list of the most important medicinal plants found at convenient distances from the city of Bahia has been furnished by the United States Consul there :—

Angelica (*Gentiana rubra*).—Aromatic, antiseptic, and anti-spasmodic; a remedy against intermittent fevers.

Arco leaves.—A substitute for the coca leaves of Peru; a stimulating and strong tonic, yielding cocaine.

Araroba or Goa powder.—This is a powder taken from the heart wood of a tree known locally as "amargoso do matto" (Vouacapoua araroba), which contains a substance known as chrysarobin, used in the treatment of skin diseases.

Barbatimão bark.—The inner bark contains phosphate of lime, tannin, and an alkaloid similar to quinine; it is a sedative, and reduced to powder makes an excellent dentifrice.

Cajueiro (*Anacardium occidentale*).—The bark is astringent and is an efficacious remedy against diabetes.

Caroba leaves.—Anti-syphilitic and anti-bubonic; well-known in Brazil as a powerful blood cleanser, used externally and internally. It is a vegetable mercury and is said to be superior to sarsaparilla and other blood purifiers.

Cambará leaves.—A strong sedative and expectorant, for bronchitis, coughs, and pulmonary ailments.

Cameleão da costa.—A remedy for stomach trouble.

Cestrum leaves.—A strong narcotic, said to be poisonous; also used in baths against hæmorrhoids; a powerful insecticide. The damp leaves are applied to wounds, first inflaming them, but afterwards cleansing and healing them.

Congonha.—A stimulant, diuretic as a tea.

Gervão.—Aids digestion, and eases laborious births.

Imbauba.—Remedy against coughs, bronchitis, and asthma.

Imburana.—Inner bark contains coumarin; it is aromatic, an expectorant and a stimulant.

Ipecacuanha.—This is a shrub growing in the shade of the forest, the root of which is dried and powdered for use in medicine. It is valued as an expectorant, diaphoretic, and emetic. It is not cultivated, but care is taken in digging up the plants to leave sufficient roots in the soil for another crop.

Jaborandi leaves.—Aphrodisiac, sudorific, and stimulating. From these leaves is extracted pilocarpine, which is used in tonic preparations for the hair.

Jurubeba (*Solanum paniculatum*).—Remedy for congestion and maladies of the liver.

Loco leaf.—A vegetable caustic.

Carnauba wax.—A tasteless, aseptic wax extracted from the leaf of a palm-tree known locally as the "carnaubéira," and employed in the preparation of ointments, pomades, and pills.

Mamona.—This is Portuguese for the castor plant, which was introduced into Brazil from India and China by the earlier colonists, but spread so quickly as to have the appearance to-day of a forest plant. Both the seed and oil are exported from Bahia in increasing quantities each year.

Manaca root.—Anti-syphilitic vegetable mercury.

Jatobá gum.—Jatobá is a name applied to several species of trees found in the valley of the River São Francisco, which traverses the northern and western parts of the State of Bahia. The gum which is extracted from this tree is employed in the composition of syrups for pulmonary affections. It is variously known locally as jatobá, jatahy, and jutahy.

Jatobá bark.—The bark of the above-mentioned tree is also of value in the preparation of medicines, and is employed as an astringent and carminative.

Mango tree (*mangifera indica*).—The leaves are anti-asthmatic.

Mentrasto.—A plant, stimulating against colics and used in fevers; also in baths, to cure weakness.

Milhomens (*Aristolochia cymbifera*).—Used against paralysis, dropsy and stomach trouble.

Mulungu (*Erythrina mulungu*).—The inner bark is a powerful sedative, narcotic, and anti-spasmodic, and is a substitute for belladonna; it also exercises a special action on the liver.

Pareira brava root (*Cissampellos pareira*).—A strong tonic, remedy for stomach trouble, bladder trouble, beri-beri, brain fever, and meningitis.

Pao ferro.—A bark used against diabetes; the seeds furnish a strong tonic and diuretic.

Purga de campo.—Remedy for fevers, pleurisy, tumours, and cancerous wounds.

Pindahiba.—Remedy for stomach trouble and for intestinal flatulence.

Quina-quina.—A bark used against fevers.

Quitoco.—Carminative, anti-hysteric, and digestive; used in baths for muscular pains in the body.

Samambaia.—Used for rheumatism.

Velame de campo.—Blood cleanser, anti-syphilitic and anti-rheumatic, for skin diseases and swelling of the glands.

INDIAN HIDES AND SKINS.

In 1916 the Secretary of State for India authorised the Committee for India of the Imperial Institute, of which Sir Charles McLeod is Chairman, to conduct an inquiry into the possibilities of increasing the trade in Indian raw materials with the United Kingdom and elsewhere in the Empire. Special committees, including commercial experts, were formed to deal with various materials. The reports of these committees, which contain important information and recommendations regarding the extension of the industrial utilisation of Indian raw materials, are in course of publication as a series of volumes by Mr. John Murray.

The first volume, relating to Indian hides and skins, which has been issued, contains the

reports of the Hides and Tanning Materials Committee on cowhides (kips), buffalo hides, and goat and sheep skins, and also a detailed account of the trade in Indian hides and skins. The most important of these products are kips and goat skins. Before the war the value of the annual exports of kips from India was about £4,000,000, whilst goat skins to the value of over £2,000,000 were annually exported, and in addition over £1,000,000 worth of tanned goat skins. The annual values of the buffalo hides and sheep skins exported from India before the war were about £1,500,000 and £900,000 respectively.

At one time a large proportion of the exports of raw Indian kips was tanned in this country, but subsequently both the tanning of the hides and the export trade from Calcutta gradually passed into German hands. In 1913-14, the value of the kips exported to Germany amounted to £2,000,000, and to Austria £750,000, whilst those shipped to this country had a value of only £63,000. The Report deals with the measures necessary to recover this important trade and to keep it in British hands, and recommendations are made as to the necessary conditions for re-establishing the tanning of Indian kips on a large scale in this country. One of the principal recommendations was the imposition in India of an export duty on the kips, with a rebate to tanners within the British Empire, and this measure has since been adopted by the Government of India and is now in force. The Committee also favour increased tannage in India.

Most of the goat skins exported from India are shipped to the United States, where they are tanned by the chrome process for the production of glacé kid, which is largely sent to this country. It is believed that a great extension of chrome tanning here and throughout the Empire is possible, as large quantities of raw goat skins are available in India and other British Possessions. The fact that a preferential export duty on raw goat skins, similar to that on kips, has now been imposed by the Government of India should contribute to this end.

Before the war, goat skins tanned in India were largely shipped to London for disposal, but the leather was mostly utilised in foreign countries for the manufacture of fancy articles, which in turn came back to this country.

NOTES ON BOOKS.

INDUSTRIAL CONTROL. By F. M. Lawson, Assoc.M.Inst.C.E., A.M.I.Mech.E. London: Sir Isaac Pitman & Sons, Ltd.

This book contains many original and novel ideas. It is based on a course of lectures delivered before the University of Sheffield, in which Mr. Lawson described a system he has devised for what may perhaps be not unfairly termed industrial or factory book-keeping. He himself calls it a system of "exposed records," and its main principle consists of the substitution of diagrams and charts for the ordinary books of account, or perhaps the addition of such diagrammatic methods to the ordinary system of book-keeping. A main feature of the system is that the "records" are open to general inspection, and it remains to be seen how this feature will commend itself to manufacturers, who are at present certainly not inclined to encourage publicity of their methods.

To describe the scheme in any detail within the space available for a brief notice would be impossible. For this reference must be made to the book itself. It must suffice to say that it is most ingenious and thoroughly scientific. A moderate number of charts and "exposed record boards," all available for immediate and simultaneous inspection, appear to be capable of giving a diagrammatic record of the actual condition and working state of a factory, showing at once the stock in hand of material, the state of progress of the different jobs in hand, and the available amount of finished goods, articles, machines, etc., ready for sale or delivery. The author gives details of the charts, etc., required for several actual factories. One is a file works in which only a single article is made, but in a great variety of different sorts, and from a limited variety of material; another is a manufactory of safes, in which the assemblage of a large number of parts is required, after the parts have been completed. In both these specified cases, it is fair to say that Mr. Lawson gives the names of the firms to whose works his system has been applied, and they speak in highly favourable terms of its value.

Only an expert in factory organisation would be justified in expressing an opinion on the practical value of the new system, or could say whether existing methods are as deficient as Mr. Lawson certainly thinks. In theory, however, the new ideas seem to be feasible, and to possess certain obvious advantages. If a general *conspectus* can thus be provided of all that is going on in the different departments of a factory, the work of the manager or superintendent must be greatly facilitated. He can see at once which departments are behindhand, and perhaps keeping back some particular order (or it may be a whole series of orders), for the want of some special part. He can tell when the stock of some particular material or some particular part is getting low, and generally can facilitate the uniform and steady progress of all the work in hand.

The introduction of scientific and ordered method, in place of the ancient "rule of thumb," cannot fail to be beneficial. For this reason it may well be worth while for the directors, managers, and proprietors of many manufacturing concerns, however well satisfied they may be with their own methods, to consider whether those methods may not be capable of improvement by the introduction of some of Mr. Lawson's novel and ingenious ideas.

GENERAL NOTES.

Destructive Insects.—A leaflet (No. 22) of the Ministry of Agriculture, deals with the diamond-back moth, and describes methods of control. Diamond-back caterpillars infest turnips, swedes, cabbages, kale, and other plants of the group *Brassica*, and sometimes cause considerable injury. Ichneumon flies (*Limneria gracilis*, Gravenhorst) attack this moth, and although they do not increase sufficiently in the case of an epidemic, they save the country from an annual recurrence of the pest. Diamond-back caterpillars are also devoured in large numbers by starlings and other birds.

Rare Metals in Ontario.—In addition to being the premier mining province of Canada as regards gold and silver, Ontario produces other rare metals that are even more valuable than gold. During the past year platinum and palladium were recovered at Port Colborne, and also by the International Nickel Company at its Bayonne refinery. At the latter, according to *Production and Export*, 19,528 tons of Bessemer matts were treated during the year, from which platinum, palladium, rhodium, osmium, iridium, and rutheorium were recovered. In all, 2,770 fine ounces were obtained, the estimated value being $200,000. Quotations on the rarer metals are difficult to obtain. The average price of platinum for the year was $114 per fine ounce. Palladium has been valued at $150. Iridium is now quoted nominally at $300 per ounce troy. The average value of iridium imported into the United States in 1918 was $114, and for osmium it was $58 per ounce in 1917.

Afforestation in the United Kingdom.—*Nature* reports that landowners have shown considerable sympathy with the objects of the Forestry Commission, and in several cases free gifts of land or long leases on specially favourable terms have been obtained. The area of land acquired in the United Kingdom is as follows:—England, 9,177 acres; Wales, 6,329; Scotland, 23,472; and Ireland, 4,716. This is exclusive of land acquired by the Irish Agricultural Department and administered by the Commission. Negotiations are in progress in respect of 24,973 acres in England, 7,900 in Wales, 6,956 in Scotland, and 7,000 in Ireland; and land on other estates is under consideration. The area planted during 1919-20 was 1,585 acres, most of which is showing satisfactory progress. A school for the forestry training of disabled ex-Service men is about to be opened in the New Forest. A similar school is already in existence at Birnam, near Dunkeld.

Hydro-Electric Works in Ceylon.—According to *The Times Trade Supplement*, investigation of the hydro-electric resources of Ceylon, which was interrupted by the war, has been again taken up by the Public Works Department of the colony. "Arrangements are being made for an early beginning in the partial conversion of the railway from steam to electricity, and also in connection with the proposed electrification of the island's industries. The experience of Ontario and Tasmania suggests that the utilisation of Ceylon's water-power resources for generating electricity will mark the beginning of an era of great industrial expansion in the Pearl of the Orient. A good supply of labour is at hand, and the opinion is held in some quarters that Ceylon is destined to become one of the great manufacturing centres of Asia."

Textile Institute Congress.—The Autumn Congress of the Textile Institute, whose head-quarters are in Manchester, is being held this year in London at the house of the Royal Society of Arts. At the opening meeting on Thursday evening, September 30th, Professor H. Maxwell-Lefroy, F.R.S., of the Imperial College of Science and Technology, will deliver the Mather Lecture, his subject being "Insects as Controlling Factors in the Supply of Cotton and Textile Materials." On Friday morning, October 1st, the President of the Institute (Sir Herbert Dixon, Bt.) will address the Congress, after which Mr. Oscar S. H. Hall, M.I.M.E., of Bury, will submit a paper on "Woven Fabrics: Achievements and Possibilities." On the same day members of the Institute will be entertained by the Clothworkers' Company at their hall, and afterwards visit the Exhibition of the British Institute of Industrial Art. On Saturday, October 2nd, a visit will be paid to the National Physical Laboratory. In 1917 the then President, the Right Hon. Sir William Mather, started a Foundation Fund for the development of the Institute, and on his retirement, in 1918, contributed a further sum of £1,000. Under his successor, Sir Frank Warner, K.B.E., the fund has risen to upwards of £11,000, and it is anticipated that in due course the amount aimed at, £50,000, will be realised. A gift of £2,000 from Mr. John Crompton, of Manchester, in memory of his son, who fell in the war, has been devoted to providing prizes annually for design and structure of woven fabrics, the competitors being advanced students at technical institutions.

"The Coal Fire."—A report entitled "The Coal Fire," which describes the work carried out by Dr. Margaret Fishenden in connection with research into domestic heating, and the efficiency of open fires, has been published for the Department of Scientific and Industrial Research by H.M. Stationery Office (price 4*s*.). This investigation, which was directed by the Air Pollution Advisory Board of the Manchester City Council and given grants-in-aid by the Research Department, has yielded a collection of carefully ascertained data from which, it is believed, a new departure can be made in dealing with the whole question of the use of coke and other forms of smokeless solid fuel in domestic fires.

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FRIDAY, SEPTEMBER 17, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

INDIAN SECTION.

SPECIAL MEETING.

On FRIDAY, OCTOBER 15th, MR. THOMAS M. AINSCOUGH, O.B.E., His Majesty's Senior Trade Commissioner in India and Ceylon, will read a paper on "British Trade with India."

The chair will be taken at 4.30 p.m. by SIR CHARLES C. McLEOD.

INDIAN SECTION COMMITTEE.

The following is the list of the Indian Section Committee, as appointed by the Council:—

Alan A. Campbell Swinton, F.R.S. (Chairman of the Council).
Sir Charles Stuart Bayley, G.C.I.E., K.C.S.I. (Chairman of the Committee).
Lord Ampthill, G.C.S.I., G.C.I.E.
Sir Charles H. Armstrong.
Sir Arundel T. Arundel, K.C.S.I.
Sir J. Athelstane Baines, C.S.I.
Sir Steuart Colvin Bayley, G.C.S.I., C.I.E.
Sir Charles H. Bedford, LL.D., D.Sc.
Thomas Jewell Bennett, C.I.E., M.P.
Sir M. M. Bhownaggree, K.C.I.E.
Lord Carmichael, G.C.S.I., G.C.I.E., K.C.M.G.
David T. Chadwick, I.C.S.
Sir Valentine Chirol.
Sir William Henry Clark, K.C.S.I., C.M.G.
William Coldstream, B.A.
Laurence Currie, M.A., J.P.
Earl Curzon of Kedleston, P.C., K.G., G.C.S.I., G.C.I.E.
James Fairbairn Finlay, C.S.I.
Sir Frederic W. R. Fryer, K.C.S.I.
Colonel Arthur Hills Gleadowe-Newcomen, C.I.E., V.D.
Sir Krishna Govinda Gupta, K.C.S.I.
Colonel Sir Thomas Hungerford Holdich, R.E., K.C.M.G., K.C.I.E., C.B., D.Sc.
Sir Philip Perceval Hutchins, K.C.S.I.
Lord Inchcape, G.C.M.G., K.C.S.I., K.C.I.E.
Lord Islington, P.C., G.C.M.G., D.S.O.
Sir Henry Evan M. James, K.C.I.E., C.S.I.
Louis James Kershaw, C.S.I., C.I.E.
Sir Henry Ledgard.
Major-General Beresford Lovett, C.B., C.S.I.
Sir Charles Campbell McLeod.
Colonel Sir Arthur Henry McMahon, G.C.M.G., G.C.V.O., K.C.I.E., C.S.I.
Sir John Ontario Miller, K.C.S.I.
Right Hon. Sir Joseph West Ridgeway, G.C.B., G.C.M.G., K.C.S.I.
N. C. Sen, O.B.E.
Colonel Sir Richard Carnac Temple, Bt., C.B., C.I.E.
Carmichael Thomas.
J. A. Voelcker, M.A., Ph.D., F.I.C.
N. N. Wadia, C.I.E.
Sir Frank Warner, K.B.E.
Sir Henry Trueman Wood, M.A.
Colonel Charles Edward Yate, C.S.I., C.M.G., M.P.
S. Digby, C.I.E. (Secretary).

PROCEEDINGS OF THE SOCIETY.

NINETEENTH ORDINARY MEETING.

WEDNESDAY, MAY 5th; SIR HENRY TRUEMAN WOOD, M.A., Vice-President and Chairman of the Council of the Society, in the chair.

THE CHAIRMAN said it was not the first time that Dr. Mees had appeared in the Society's hall, because just eight years ago he read an excellent paper on Screen Colour Photography, for which he received the Society's medal. At that time the Lumière process had only lately been invented, and Dr. Mees gave a very interesting account of the whole method of colour photography, and discussed the technical qualities of the subject in a very clear and admirable way. Shortly after that he left England to take charge of the research laboratory which had been established by Mr. Eastman, the founder of the Kodak Company, at Rochester, in the United States, and under his care it had developed into what was distinctly the finest photographic research laboratory in the world. Those who knew Dr. Mees were sorry that this country lost the benefit of his great scientific knowledge, but he had had opportunities in America which he could not possibly have had in England, and he had made the best possible use of them.

The paper read was—

A PHOTOGRAPHIC RESEARCH LABORATORY.

By C. E. KENNETH MEES, D.Sc. (Lond.).

The Research Laboratory of the Eastman Kodak Company was established in 1912 to study the problems involved in the production and use of photographic materials.

Photographic research occupies a somewhat unique position in the field of applied science,

both because photography is so much used in other scientific work that interest in it is very widespread, and because the methods of photographic research are so different from those of all other branches of scientific work, that it is rare for the professional scientific man to understand them.

Very little work on the theory of photography has been done in the universities, and there are, perhaps, three reasons for this: In the first place, information with regard to the theory of photography is not easy to obtain; there are few books on the subject, and these deal generally with only a limited part of the field, and the original papers to which recourse must be had for information are scattered through a wide range of photographic and other journals. In the second place, work on the theory of photography necessarily involves work with photographic materials, and these materials are now made entirely by manufacturing companies, the methods of manufacture not being disclosed, so that the actual nature of the photographic materials themselves is but little understood by the user of them. In the third place, the apparatus required for photographic research is very specialised and somewhat expensive.

Our knowledge of photographic theory we owe chiefly to enthusiastic amateur photographers, supplemented in recent years by the research done by the photographic manufacturing firms, and it was in order to produce a considerable increase in the amount of this specialised photographic research work that the Eastman Kodak Company established its research laboratory.

The work of the laboratory deals, of course, not only with the theory of photography, but with many points of practical importance, both in the manufacture of photographic materials and apparatus and in their use, and the laboratory is divided into different sections corresponding to the general divisions of science, notably physics, chemistry, and practical photography, the workers in these divisions collaborating in investigation of the problems with which the laboratory is concerned.

The branches of science which are of chief importance in photographic problems are those of optics in physics, and of the colloid, physical and organic divisions of chemistry, and Fig. 1 represents an attempt to show the relations of these branches of science to photography.

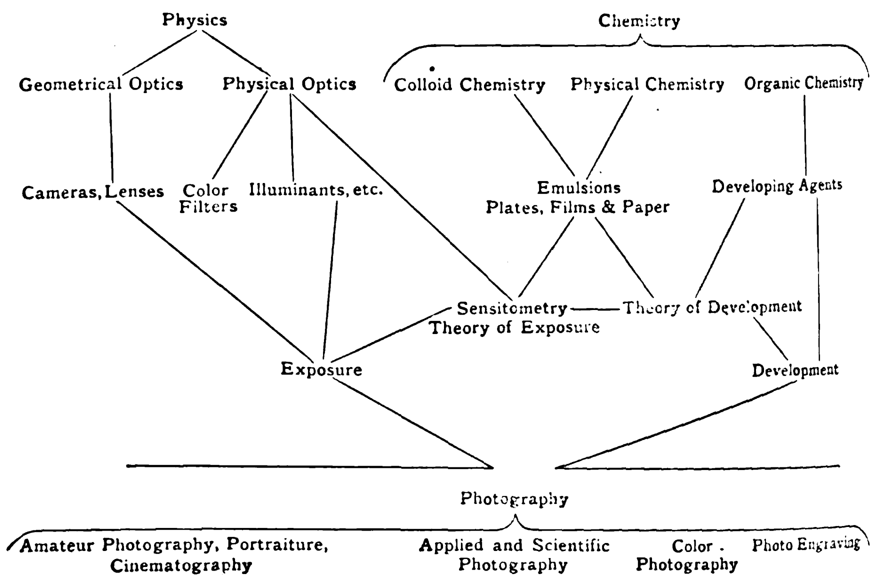

FIG. 1.

Optics deals on its geometrical side with the materials used in photography—cameras, lenses, shutters, etc.—and on its physical side with such materials as colour filters and illuminants, but especially with the study of the relation of the photographic image to the light by means of which it was produced—a study which is known by the name of sensitometry.

The manufacture of the sensitive material itself, which in the case of modern photographic plates, films, and paper, is called the "emulsion," is a province of colloid and of physical chemistry, colloid chemistry dealing

with the precipitation and nature of the sensitive silver salts formed in their gelatine layer, while physical chemistry informs us as to the nature of the reactions which go on, both in the formation of the sensitive substance and in its subsequent development after exposure.

The organic chemist prepares the reducing agents required for development, and the dyes by which colour sensitiveness is given to the photographic materials and by which the art of colour photography can be carried on. While the physicist, therefore, deals with sensitometry and the theory of exposure, the chemist must deal at the same time with the theory of development and with the conditions relating to the development of photographic images.

A laboratory, therefore, for the study of photographic problems must be arranged with a number of sections such as are shown in Fig. 2. There will be physical departments, dealing with sensitometry and illumination, reflection and absorption, colorimetry, spectroscopy and geometrical optics. There will be a department of colloid chemistry, one of physical chemistry, one of organic chemistry, one of photo-chemistry (to deal with the action of light upon a plate), and finally a number of photographic departments, dealing with photographic chemistry, with portraiture, colour photography, photo-engraving, motion picture work and X-ray work, and the results obtained in all these departments will be applied first to the theory and then to the practice of photography.

In order to concentrate the different departments of the laboratory upon the photographic problems that arise, and to ensure that on each problem the full knowledge and experience of the different specialists is made available, the main lines of work under investigation are discussed at a morning conference at the beginning of the day's work, one day of the week being assigned to each special subject, so that on Monday, for instance, those doing work in relation to one subject meet; on Tuesday the same men or other workers discuss a second aspect of the work of the laboratory, and so on. The laboratory organisation, then, resolves itself into these several groups, interlocked by their common members, who are dealing with a number of different lines of work.

The Research Laboratory was built in 1912, and occupied at the beginning of 1913. It con-

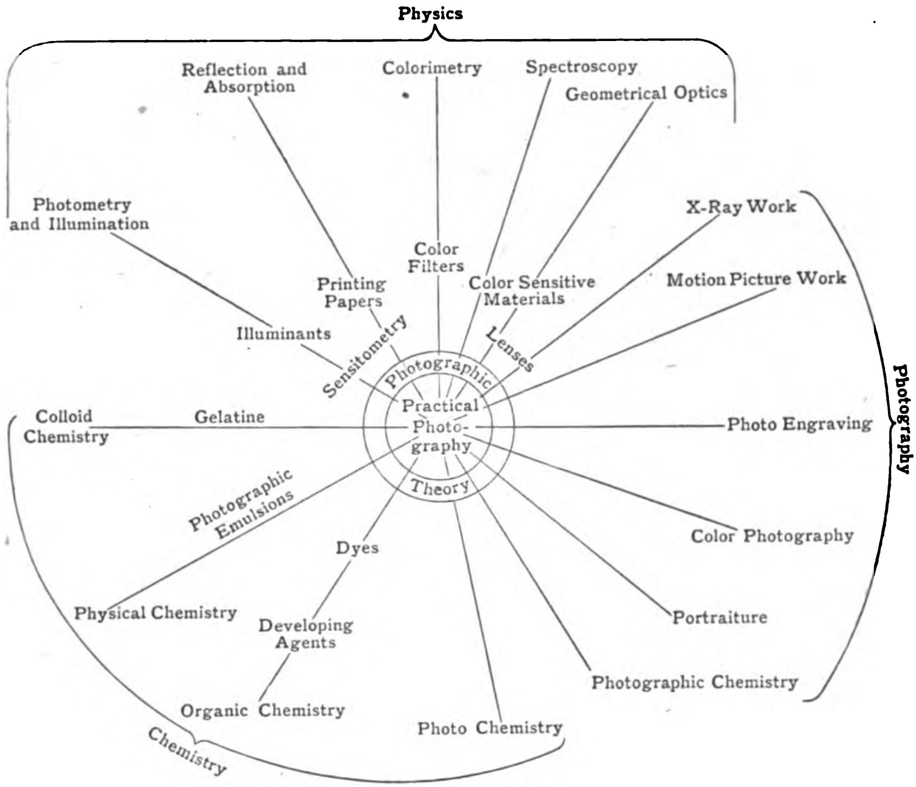

FIG. 2.

sists of a three-story building about 60 feet by 76 feet with a full-sized basement, the basement being utilised for an experimental photographic manufacturing plant. It contains in the centre a number of emulsion rooms, comprising both small rooms for individual workers and larger rooms in which operations on a semi-manufacturing scale are carried on. The basement also contains the machinery necessary for the drying of the photographic products which the laboratory makes experimentally. Since such experimental manufacturing can only be done on a considerable scale, the drying apparatus approaches in dimensions that required for a small factory. The coating of plates, films, and papers is done on the ground floor, plates being made and packed in this department, so that the laboratory is in a position to manufacture moderate quantities of any sensitive material on which it may be working. Since the machines needed for this manufacturing require skilled workers, they must be kept in daily operation. The Research Laboratory, therefore, manufactures any special products which may be required for sensitive or experimental work, and collaborates with universities and other scientific workers throughout the country. Light filters of all kinds are also made in this manufacturing department under the direct control of the research workers in the laboratory.

On the ground floor, in addition to the sensitive goods department, is a library which contains a full collection of technical works dealing with photography, physics, and chemistry; the photographic section is especially complete.

On the second floor of the laboratory building are the physics laboratory and the section of physical chemistry. The physics laboratory is divided into a spectroscopic room and computing room, a photometric room, and several dark rooms devoted to sensitometry.

On the third floor is a large projection room in which are placed the optical instruments requiring considerable length for their work. In this room are the projection machines and a lens testing bench designed and constructed in the laboratory especially for the exact measurement of photographic lenses. The apparatus for the entire laboratory has largely been designed especially for its work, and constructed in the company's machine shops.

The third floor of the building is given up chiefly to photographic work, though it contains several chemical laboratories. It includes a large studio with an artificial lighting installation, which is used for portrait and colour photography, while another studio is devoted to copying, photo-engraving and commercial photography. Other laboratories are concerned with photographic chemistry, with the physical chemistry of development, and with radiography.

Most of the chemical laboratories are apart from the main building, and include laboratories equipped for organic chemistry and for the synthesis of organic reagents. The work of the laboratory has now outgrown its building, and plans for a considerable addition have been drawn up. Until those plans can be realised in practice the overflow work from the laboratory is being housed in adjacent buildings, in order to provide for the very rapid expansion which the work continues to show.

The work of the laboratory is published in the form of scientific papers, these being printed in the usual technical journals to which the special subject of the paper may be appropriate, and then at intervals, as sufficient papers accumulate, full abstracts of all the papers are collected and published in a volume under the title of "Abridged Scientific Publications." At the time of writing, about one hundred papers have been completed.

The scientific work of the laboratory can be classified under the headings of the physics of photography, the chemistry of photography, the reproduction of tone values by photography, and work on special photographic processes, including those required for photography in natural colours. In addition to this, a considerable amount of research has been done in pure chemistry and in the various branches of applied optics, which are closely allied to photography.

The Physics of Photography.

Photographic sensitive surfaces do not consist of continuous coherent films of homogeneous material, but have a definite granular structure, the sensitive material itself consisting of grains embedded in an insensitive matrix, so that in considering the properties of a sensitive photographic material we are considering really the properties of a collection of sensitive grains, which may differ considerably from each other in their individual properties. The properties of such a collection will be the statistical average of the individuals composing it, and in order to understand the properties of a sensitive material we must therefore consider the properties of the individual grains and their

relation to the aggregate material of which they are units.

The question at once arises: Do these grains consist of crystals of pure silver halide, or of a gelatine silver complex? Microscopical study shows it to be probable that the grain is a pure silver halide crystal, for when these crystals are exposed to the action of water no swelling at all is observable, even under the highest power of the microscope. The grains of silver bromide prove to be regular semi-transparent crystals belonging to the isometric system, occurring chiefly in triangular and hexagonal tablets and in needles of various thicknesses, these needles being formed in the same way as the tablets. As they occur in a gelatine emulsion, these grains are doubly refracting, though this would not have been expected from their crystalline form. Silver bromide can be crystallised out from its solution in ammonia to show all the forms in which it occurs in emulsions, and the physical chemistry of the preparation of these crystalline grains is under investigation in the laboratory at the present time.

When the silver halide grains are developed, the crystalline form is lost, the silver being deposited in a sponge-form in soot-like particles, the form of the deposit being generally considerably distorted from the original shape of the silver bromide crystal grain, though in some cases the original shape is fairly well reproduced in the deposit of metallic silver.

In viewing a negative by transmitted light we cannot, of course, see these isolated grains with the naked eye, but we see a conglomeration caused by the penetration of light through the interstices between the grains distributed throughout the emulsion layer, and thus we obtain regular large patches of chains of grain, the pattern and regularity depending upon the particular type of emulsion used. This granularity, the formation of which can be studied by the examination of a vertical section through the film, is what is meant by the "graininess" of photographic negatives in general, and is the grain met with in enlarging, in projection, and in portraiture.

The granular structure of a photographic emulsion involves a limit to the resolving power of the emulsion; that is, it requires a certain finite distance between two points of light falling upon the film in order that they may record themselves as separate deposits of silver grains. The study of the resolving power of a photographic emulsion can be accomplished by the examination of the spread of the edge of an image. Suppose, for instance, that we lay upon a photographic film a knife edge and then illuminate this knife edge vertically from above; some of the light passing the knife edge will be scattered into the shadow by reflection from the grains of silver bromide and will produce developable grains within the shadow, so that upon development we shall obtain a distinct extension of the image beyond the edge into the shadow. If we determine the relation between the number of grains rendered developable and the distance from the edge, we shall have a relation which will depend upon the scattering of the light by the silver bromide grains and upon the absorption of that light by the grains. These two factors we might term the "turbidity" and the "opacity" of the emulsion.

An emulsion having high turbidity and low opacity will have a very low resolving power. On the other hand, even if the emulsion has high turbidity, if its opacity is also high, the resolving power may be good. A typical example of this is the wet collodion plate, in which the turbidity is considerable, but the opacity of the silver iodide for blue-violet light is so great that the resolving power is high. In the grainless Lippman emulsion the resolving power is high if the emulsion is very clear, because the turbidity is very small, but the opacity is also small, so that the slightest increase in turbidity may make the resolving power very low.

A convenient way of measuring resolving power is to photograph a converging grating, observing the point in the photograph at which resolution first occurs, and from this a numerical measurement of the resolving power can be obtained.

The importance of photographic resolving power in relation to many branches of scientific work, and especially spectroscopy and astronomy, is obvious, and much work is being done in the laboratory upon these applications.

The study of the relation between the exposure of the photographic material and the blackening produced after development is generally termed "sensitometry," since this study was first undertaken by Hurter and Driffield in 1890, in order to determine the sensitiveness to light of photographic plates. The blackening is stated in terms of the optical density which is proportional to the mass of silver present in a unit area. The photographic material, plate, or film is given a series of increasing exposures so that after development a number of steps of density are produced, each step corresponding to a certain

level of exposure. The density is then measured optically and plotted against the logarithm of the exposure, by which means a curve is obtained which, for the greater part of its length, is a straight line, though at the beginning and end it departs from rectilinearity. The curves obtained in this way are known as the "characteristic curves" of the material. (See Fig. 3.)

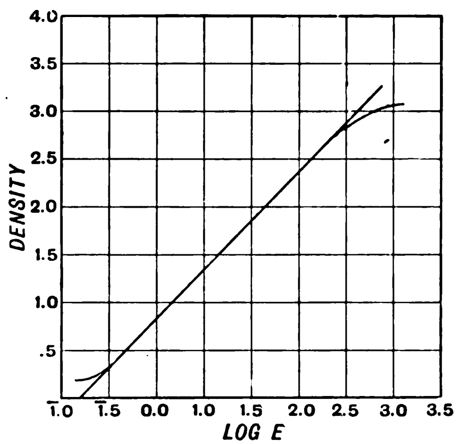

FIG. 3.

At the beginning of the curve, in what is termed the "period of under-exposure," the density increase grows until it reaches a maximum, corresponding to that of the straight line portion where the increase of density is proportional to the increase in logarithmic exposure, and at the top of the curve in what is termed "the period of over-exposure" the increase of density lessens until finally the density becomes constant. This constancy continues for a long period, after which reversal sets in. Such curves are known as the characteristic curve of the materials.

Inasmuch as emulsions are not homogeneous, but each emulsion contains grains of all sizes and of varying sensitiveness, the shape of the curve will depend upon the distribution of the different sizes of the grains in the emulsion. With a homogeneous emulsion we should have a simple curve with short over- and under-exposure portions, and by adjusting the sizes of grain so that there is a sufficient distribution of smaller and larger grains around the mean size, we can diminish the size of the under-exposed portion and obtain a longer straight line portion to the curve.

THE CHEMISTRY OF PHOTOGRAPHY.

While the grain structure of the emulsion and its reaction to light must be considered a branch of physics, the development of the emulsion is certainly closely related to physical chemistry. One of the most interesting pieces of work in the laboratory has been the study of the photographic developers in relation to their behaviour in the development of the latent image, and the relation of the constitution of the many possible compounds to their properties is being attacked in the laboratory by the collaboration of the department of organic chemistry, which prepares the compounds in question, and of a special laboratory which deals with the physical chemistry of developers. In this laboratory the developers are examined both by their action upon the photographic emulsion and also by the recognised methods of physical chemistry. The most fundamental property of a developing agent is its reduction potential, and this should apparently be measurable electrically by comparing the electromotive force produced on a platinised cathode immersed in the developing agent with the potential of an electrode charged with gaseous hydrogen.

The rate of development is dependent on two factors: first, on the rate of the chemical reaction itself; that is, on the solution of silver bromide, its conversion into metallic silver, and the precipitation of the metallic silver into a solid form; and, secondly, on the rate of diffusion of the developer to the silver bromide grain, and of the products of development away from the grain. The second of these factors has by far the greater influence in settling the rate of development, though the time of first appearance of the image appears to be dependent chiefly upon the rate at which the developer attacks the silver bromide grain. It is in the rate of attack on the silver bromide grain that the reduction potential plays so great a part, but this rate of attack under ordinary conditions is limited by the rate of solution of the silver bromide, and a developer does not attack the silver bromide grain proportionally faster by reason of an increased reduction potential.

The reduction potential of a developer, in fact, may be compared to the horse-power of an automobile, which for other reasons than the power of its engine is limited in speed. If we have two automobiles, and they are confined to a maximum speed of twenty miles an hour, then on flat roads the one with the more powerful engine may be no faster than the weaker, but in a high wind, or on a more hilly road, the more powerful engine will allow the automobile to keep its speed, while with a weaker engine the speed will fall off; we can, indeed, measure the horse-power of an automobile by the maximum

grade which it can climb at a uniform speed. In development the analogy to the hill is the addition of bromide to the developer, since the addition of bromide, by the lowering of the solubility of the silver bromide, greatly delays the chemical reaction in development, and the higher the reduction potential of a developer the more bromide is required to produce a given lowering of the density, so that we can measure the reduction potential by the amount of bromide required to produce a given effect. If we measure the common developers in this way, we shall find that glycin has the lowest reduction potential, then hydroquinone, then pyro and paraminophenol, and finally diamidophenol has the highest.

Reproduction of Tone Values.

In photography the object is to produce on the observer the same impression of the relative brightnesses of the scene reproduced in the print as was produced at the time that the photograph was taken. It is clear that a study of this can be divided into two sections, one dealing with the objective reproduction in the print of the scale of light intensity which occurred in the original subject, and the other concerned with the subjective impression produced on the observer, both at the time of viewing the subject and later when viewing the print. With regard to the objective side of the subject, let us consider first of all the way in which a scale of brightnesses is reproduced in the photographic process from the original subject through the negative to the print.

There are four separate sections involved in this investigation: first, the study of the range of brightnesses occurring in natural objects, such as one is required to photograph; second, the study of the way in which the photographic emulsion translates a scale of light intensities into deposits of metallic silver in the negative; third, the study of the properties of photographic printing papers, and the relation of the reflecting power of the deposits obtained in them to the scale of light intensities to which they were exposed; and, fourth, the study of the accuracy with which the tone values of the original are rendered through the negative on to the printing paper.

Until recently the scale of rendering of a negative material was all that had been fully investigated. This was done by Hurter and Driffield as has already been mentioned. They studied the relation between the exposure of the photographic material and the blackening produced, but in order to render possible the study of the reproduction occurring in photography, an investigation of the sensitometry of papers was also necessary.

In the first place, an instrument was designed by means of which the light reflected from small areas of the exposed print could be measured. Papers were then exposed for known periods of time, developed, the reflecting power of the developed image measured and a curve plotted of the logarithm of the reciprocal of the reflecting power against the logarithm of the exposure. (Fig. 4.) Several constants were found to ex-

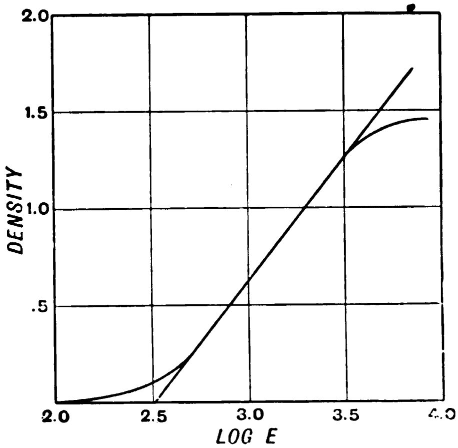

Fig. 4.

press the behaviour of photographic papers; thus, any paper had a maximum density, that is a minimum reflecting power representing the deepest black which could be obtained upon it. It showed, also, a typical scale or total range of exposures through which any difference could be obtained with an alteration of exposure. Again, the straight line portion of the curve showed a definite steepness or "gamma," as we call it, and finally the length of the straight line portion is of great importance, since it is only throughout this straight line portion that exact reproduction can be obtained.

The method of obtaining the sensitometric characteristics of a positive material having been developed so that the results obtained were satisfactory, it remained only to combine this information with that relative to the characteristics of the negative material in order to obtain a solution of the objective phase of the tone reproduction problem. A graphic method was, therefore, developed by means of which this desired result could be accomplished. By use of this method it becomes possible to compute from the known or easily measurable factors,

such as the brightnesses in the object, the constants of the image forming system, the illumination used in making the positive, and the intensity of illumination incident upon the positive during observation, the brightness values in the positive by which the various areas of the object are reproduced. By comparing these brightness values with those of the object, a quantitative expression of the quality of objective reproduction obtained can be formulated. This solution of the objective phase, however, is not all that is desired, for as previously stated, the object in most cases of photographic work is the reproduction of the group of sensations resulting from an observation of the object.

In order to obtain the data necessary for this solution, a large amount of work has been done on visual sensitometry, which deals with the determination of the various sensibility functions of the human eye. The data of particular importance in this case are those relative to the various brightness sensibility functions, especially that relative to contrast sensibility. These data having been obtained, the graphic solution was extended so as to include also the subjective phase, and by the method as finally worked out it is possible to obtain a graphic representation of the quality of subjective reproduction. This is expressed by evaluating the characteristics of the subjective reproduction in terms of the subjective object, and expressing this evaluation as a function of the brightness in the original object.

Many interesting conclusions, some of considerable practical importance, have been drawn as a result of the work on this tone reproduction problem. Among these may be mentioned the relation which should exist between the negative and the positive material upon which it is to be printed, which may be stated by saying that the density scale in the negative should be equivalent to the exposure scale of the positive material on which the print is to be made. Another point of considerable interest, and relating particularly to the subjective phase of the subject, is that an enhancement or increase of objective contrast in the print may frequently be necessary in order to reproduce apparent contrast in the object, this being due to the fact that the contrast sensibility of the retina may be relatively low when viewing a print under a low illumination, while on the other hand the contrast sensibility is high when the observer views a brilliantly illuminated object.

Practical Photography.

Naturally, a great portion of the work of the laboratory is concerned with photographic processes, and work on all kinds of photographic processes is continually in progress. It is difficult to summarise this work in any brief form, but the work which is being done on colour photography is perhaps especially worthy of note.

There are two main divisions of the practical processes of colour photography; the processes which are known as "additive," in which the colours are produced by the superposition upon a projection screen or in the eye of beams of the primary colours; and the "subtractive" processes, in which negatives taken through the primary filters are printed in colours complementary to those filters, and these prints are then superposed.

Most of the work of the laboratory has dealt with the subtractive processes, though a good deal of research work has been done upon the filters required for the additive processes and upon such subjects as the colour of mixtures of two nearly complementary colours, work which is of considerable interest in connection with the two-colour additive processes.

In work on the subtractive process of colour photography, some interesting results have been achieved in the photomicrography of stained sections, a two-colour process having been developed which gives very good results for this purpose. The two-colour subtractive process of colour photography has also been applied to motion picture work, the pictures being made by using film coated on both sides with a sensitive emulsion, so that negatives taken through the red and green filters can be impressed in register on opposite sides of this double-coated film, and then the double images after development can be transformed into dye images complementary in colour to the filters through which the negatives were taken. In this way each picture on the film consists of two pictures of complementary colours, which give the effect of a two-colour subtractive picture. This process, of course, has the great advantage that film so made is suitable for projection in any ordinary motion-picture machine.

Owing to the intimate relation of photography to physics and chemistry, a great deal of work has been done in the laboratory in these sciences: thus in applied optics a number of studies have dealt with the reflection and transmission of light by diffuse media and with brightness measurements, the laboratory being especially

well equipped to study absorption photometry, both with and without the consideration of colour. The study of colour itself occupies a large part of the activities of the physics department; measurements have been made on the sensibility of the eye to colour and to change of hue, and a number of investigations have been made on the use of the monochromatic and other colorimeters for the quantitative expression of colour. In physical chemistry studies have been made on the physical-chemistry of gelatine and other allied colloids, and a monograph on gelatine is now in preparation. Methods of measuring viscosity, turbidity, swelling, and other physico-chemical constants, have been developed in this department. In electro-chemistry also a great deal of work has been done. New methods for the electro-analysis of silver solutions have been worked out, apparatus for the determination of hydrogen potential has been designed, and methods for the precise determination of conductivity have been developed.

A special department of the laboratory deals with the production of synthetic organic chemicals, its purpose being to supply the lack of those materials, so essential for the research worker in organic chemistry, which we formerly obtained from Germany. A price list containing about 700 organic chemicals has been issued, and this department of the laboratory promises eventually to become a full-fledged manufacturing department, supplying synthetic organic chemicals to the universities and the laboratories of the United States.

The division of organic chemistry was concerned during the war chiefly with the production of developing agents and dyes to replace those which had been previously purchased from Germany, but it is an important section of the photographic research laboratory, since chemistry is concerned with so many sections of the laboratory's work. The whole organisation of the research laboratory, however, is really a section of a wider division of the Company's activities, since it is a part of the Development Department, which is responsible for the introduction and development on a manufacturing scale of new products of all kinds. The Development Department contains other sections in addition to the laboratory itself, experimental shops in the camera factories where apparatus is built, and departments for the study of inventions submitted from outside or of suggestions originated in the Company. All work done in the Research Laboratory which can be used in the Development Department is at once referred to it, and the completest co-operation is ensured by the control, both of the laboratory and the Development Department, under the one head.

DISCUSSION.

THE CHAIRMAN (Sir Henry Trueman Wood) said the question of industrial research was now one in which the public took a great interest. We had had a lesson from Germany as to its value, and the man in the street was beginning to realise what had been known for years past to the man in the laboratory. The Government had established a special department for industrial research, and was encouraging the development of laboratories in various branches of trade. There was one objection to the industrial trade laboratory; it must be founded for the benefit of the particular business supporting it, and naturally that individual or company would be very apt to preserve extreme reticence as to the result of its work; it desired to keep its information to itself, and not let its rivals have the benefit of it. That had been very marked in German laboratories. But there was another side to the question, namely, that although the particular business might gain a great deal by keeping its results to itself, it would gain more in the long run by the publication of the results and by the general advance in the progress of the business. He thought it was quite clear from what the author had said about his own laboratory that that view was taken to a very large extent by those who started it. Photography as an industry was comparatively small, but from first to last it had been a purely scientific business and had developed on purely scientific lines. The results of scientific advance had been to build up large commercial businesses, of which that with which Dr. Mees was connected was one of the most important. He had shown that they were doing very valuable public work, and it was to be hoped that their example would be freely followed by those who were engaged in establishing similar research laboratories in this country. He thought it was being realised that better results would be obtained by throwing all the knowledge into a common stock than by trying to keep it to individual firms.

MR. W. B. FERGUSON, K.C., said he had the honour of being a member of the Council of the British Research Association—in fact, he was a Vice-President of the Photographic Research section—and he had been deeply interested in listening to Dr. Mees's paper and in seeing the pictures that had been shown. It was extremely to be regretted that the Americans had taken from this country the one man who was entitled to be considered the head of photographic research. In all research associations the great difficulty was to get hold of the Director of Research. A real director must be one who not only was acquainted with the physics and chemistry of photography, but also had some knowledge of photography

itself and the actual manufacture of photographic materials. Dr. Mees combined all those qualities. One thing about Dr. Mees was that he made no secret of his discoveries, and would tell one anything he knew. That was a rare quality in scientific men connected with trade associations. Dr. Mees had alluded to the great difficulty in finding records of research work done by former chemists and physicists. He might point out that the Royal Photographic Society had latterly published a collective volume of the research work of Messrs. Herter and Driffield, and had also added a large bibliography of the scientific work done in photographic research from 1890 until two years ago, and he thought that book would be of considerable help to those engaged in photographic research. With regard to the Photographic Research Association, it started with laboratories at University College, had a good Director of Research and valuable assistants, and a good deal had been done, but after going on for about a year, a large chemical manufacturing firm offered the Director of Research a salary which the Research Association could not afford to pay, and naturally he had gone to the works. At present the Association was on the look out for another man, and he only hoped they would succeed in finding a man with the various qualifications that Dr. Mees had described and which he possessed in the highest degree.

Mr. George E. Brown said there was one thing that might be brought to the notice of Dr. Mees, and that was the opportunity which he had in his research laboratory of enriching the English literature of photography—the general literature of photography—to which those who wished to learn would naturally turn. The English literature in that connection was a deplorable collection. If one wanted to find anything one had to go to French or German literature. Probably no one man could write a series of books which represented the knowledge of photography at the present time, but he thought it could be done by a company of men such as Dr. Mees had gathered round him.

The Chairman, in proposing a vote of thanks to Dr. Mees for his paper, said he was one of the very few men who was thoroughly competent to run such an institution as the research laboratory of which he was the head, and which he believed owed its great success to his admirable organising capacity and his very wide and extensive scientific knowledge. He only hoped it might be possible to obtain someone as much like him as possible for the photographic research laboratory in this country.

The motion was carried unanimously.

Dr. Mees, in reply, said he could not express too strongly what he felt with regard to the publication of the results of research associations, industrial or other. A research laboratory that did not publish was half dead; it was not very much good being alive if one was blind and dumb. Also, it was no good being alive if one was devoid of all means of expression, even if one could receive information, because if a man had ceased to give out information for a sufficient time he would not be interested in receiving it. The primary object of publication by a research association was to keep the men alive. If the association obtained good men from a university, keen on scientific work and accustomed to research and to free discussion, and put them into an institution and told them that they must not say anything, it was putting them into a tomb, and the men after five years ceased even to read scientific papers. They had no incentive to do so. The men in his laboratory had a very good incentive, because they were going to be criticised. He had been rather horrified at the theoretical attitude of the British research associations generally. A great deal of stress was laid on the possibility of secrecy, but he hoped they would not insist on that, because if they did they would be dead before they were born. The great difficulty in research work was to make anybody take notice of it. People were busy, and the first impulse was to take the elaborate report that had been sent to them and pigeon-hole it. It was necessary that the laboratory should not only create its new scientific knowledge, but interpret and apply that knowledge. It might start with a paper like the one he read to the Royal Photographic Society on the previous evening, on the reproduction of tone values, and after some years that would be applied to the Kodak user. The whole of that work had to be done by the energy and under the guidance of the laboratory men. They patented everything they could patent, but if a thing could not be patented it was published. Even the German firms patented and published, and the great dye works patented or published everything. A great many stories had been told about German secrecy, but all that had to be read through the war haze. As a matter of fact, the German dye works had published more chemistry than all the other agencies in the world put together, and the greater part of the German laboratories were continually publishing. One of the greatest scientific institutions in the world, the Zeiss works, were publishing all the time. It was only by such work, published freely and frankly, that industrial laboratories could come into their own in the scientific world. He did not agree with the Chairman that photography was a very small industry. In the paper he had included motion pictures as a branch of photography, and in the United States that was stated to be the fifth industry in the country, and came under the same order as textiles. The factories of Rochester made 5,000 miles of that film a day. He wanted to disclaim responsibility for what was put on the stuff afterwards! He was glad to be reminded by Mr. Ferguson that he had made a mistake in the paper. When he wrote the paper he had not seen the Herter and Driffield Memorial volume, and

did not know there was a bibliography of the entire subject of photographic science. It was a monumental piece of work of the greatest value. Mr. Brown's remarks on photographic literature were entirely correct, although he could not help wondering that a man who had been the editor of a photographic paper for so many years should still remain an optimist. The idea of any member of his staff writing a book that Mr. Brown would approve was inconceivable. They could write monographs, but the translation of them into ordinary English was not going to be done by the man who wrote the monograph. The question of clear, good books on photography was a very difficult problem. It might interest Mr. Brown to know that one of his books, called "The Fundamentals of Photography," which was written for the Kodak user and dealt with pure theory, had been published by the Company. Personally, he thought it would be necessary to look to people other than the men who were doing scientific research to give an account of it in plain, simple English for the public. The difficulty was that all the men engaged on research assumed that people who were reading the papers understood all the technical terms that were used.

The meeting then adjourned.

THE ITALIAN QUICKSILVER INDUSTRY.

Monte Amiata, situated in the Grosseto-Siena region, is the centre of the Italian quicksilver industry, and the output from this district represents approximately the national production. The ore-producing zone stretches for 40 kilometres in a direction parallel to the Apennines, and covers an area of 400 square kilometres. The entire region is mineralised, but only special pockets are sufficiently rich in ore to repay the cost of working. There are at present eight active mines. Three mines have lately been worked out and abandoned, but have been replaced by bringing in two new ones.

The most important deposit is red sulphide or cinnabar. Sometimes, but very rarely, the liquid metal is found in the form of minute drops. The wealth of the deposits does not increase with the depth of the mine, but exhausts itself at no great level. The work of extraction ceases at a depth of about 200 metres. The relative superficiality of cinnabar deposits is characteristic of mercury mining the world over. It is an advantage so far as prospecting and operation are concerned, but a drawback in shortening the life of the mine.

The future of the Monte Amiata region, writes the United States Commercial Attaché at Rome, lies in the extension, rather than in the depth, of the producing zone. Experts estimate that the region will continue to supply ore in undiminished quantity for several centuries to come. This, however, is dependent upon the discovery and exploitation of new beds. Under present conditions of abnormally high fuel and labour costs, only the richest deposits are being worked at a profit. Cheaper processes of production may be devised that will render available vast deposits of low-grade ore that are not workable at present.

The high cost of fuel is the heaviest item of expense in ore reduction. The ore is always treated on the spot, being first dried in the sun on platforms or in artificial desiccators. The old type of distilling retort ovens has been given up; they were dangerous because of their mercurial fumes and uneconomical because of waste. Two types of ovens are now in use—one for the treatment of large fragments of ore, which are mixed with charcoal in simple tank ovens, and special drop or rotating ovens for treating smaller fragments of ore. Both these types minimise dispersion, but require great quantities of fuel, both wood and charcoal. In addition, enormous quantities of timber are used as mine props for sustaining the galleries. The double call on timber for charcoal and mine props has made a devastating inroad on the scanty forest resources of the surrounding country. It is now proposed to prevent this excessive use of wood by the installation of electric ovens for ore reduction. Water power from the Apennines is available for hydro-electric energy, but electric smelting has not come up to the high expectations of its proponents.

Two minor difficulties add materially to production costs: (1) The emanations of sulphuretted hydrogen, necessitating the extensive use of electric ventilators; (2) the character of the soil—occasional strata of loose soil are encountered, which become saturated with water and cause the galleries to cave in.

The number of workmen employed in the Monte Amiata mines is about 900.

The production of mercury in these districts in 1915-18 was as follows:—

	Ore. Tons.	Metal. Tons.
1915	110,612	985
1916	132,524	1,093
1917	113,782	1,071
1918	—	1,038

The production of mercury (metal) in Idria in 1918 was estimated by the Italian Bureau of Mines to have been 600 tons, making the total output of Tuscan and Idrian mercury for the year 1,638 tons.

During the war, the Italian Government took over the entire output of mercury at 12 lire per kilo, and fixed the selling price at 25 lire per kilo. It is understood that there is a relative decline in Spain's production. Mercury is the one mineral, with the exception of sulphur, that Italy produces in considerable exportable amounts.

A proposal has been put forward by the director of the Monte Amiata mines, with the backing of three great Italian banks, for the formation of a mercury combination for the control of the world's supply. The "trust" would be composed of the Monte Amiata and Idria mines, and also the principal mines in Spain.

The quicksilver industry in Italy before the war was financed by German bankers. During the period of Italy's neutrality, control passed to Swiss financiers. Within the last two years Swiss money has been replaced by Italian under the leadership of the Banca d'Italia.

The Monte Amiata company is now purely Italian. Prospecting by Italians for new quicksilver deposits is busily going on in Dalmatia and in the Trentino.

OBITUARY.

Isham Randolph.—Mr. Isham Randolph, an eminent member of the engineering profession in the United States, died at Chicago on the 22nd ult., in his seventy-third year.

Perhaps his principal achievement was the Chicago drainage canal, which cost £12,000,000, and has a hydro-electric plant developing 40,000 h.p. Another notable piece of work he accomplished was to make a dam on end at the brink of the Niagara river, and then tip it so as to fall in the requisite position to check the serious erosion of the river bed above the Horseshoe Fall. As a member of the international board of consulting engineers for the Panama Canal, he signed the minority report which was accepted by President Roosevelt, approved by the Canal Commission, and adopted by Congress. Mr. Randolph was also on the board of advisory engineers who upheld the plans for a lock canal. He was elected a Fellow of the Royal Society of Arts in 1916.

GENERAL NOTES.

Research Department.—Professor J. B. Farmer, F.R.S., has been appointed a member of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research. The British Launderers' Research Association, having complied with the conditions laid down in the Government scheme for the encouragement of industrial research, has been granted a licence.

Cotton-Growing in Mesopotamia.—Since 1917 experiments have been conducted by an expert from the Indian Agricultural Service with a view to discovering the most suitable kinds of cotton to grow in Mesopotamia. The results of the work done in this connection, and the prospects of establishing a cotton-growing industry, are fully dealt with in the current number of the *Bulletin* of the Imperial Institute. So far, American types of cotton seem to be the most suitable. The members of a deputation of the British Cotton-Growing Association, which visited the country towards the end of last year, were very favourably impressed with its possibilities for cotton production. The acreage eventually planted will depend on the quantity of labour available and the area on which a perennial supply of water can be guaranteed. It seems likely that a total of 150,000 to 200,000 acres could be cultivated annually by the existing population if the necessary facilities, in regard to agricultural machinery, transport, etc., were provided. At a low estimate this area should produce from 15 to 20 million pounds of cotton yearly.

Electrification of New Zealand Railway.—The English Electric Company has been awarded a contract for the electrification of a section of the Midland Railway of New Zealand. His Majesty's Trade Commissioner at Wellington, in cabling this information, says that special importance is attached to this contract, as it was obtained on the merits of the tender in the face of strong American competition. The section to be electrified includes a tunnel over five miles long, and three steel bridges. A great portion is on a grade of 1 in 33, and the summit is about 2,400 feet above the sea-level. The system to be used is 1,500 volts direct current overhead contact. This is the first railway electrification in the Dominion.

Conveying Milk through Pipe Lines.—The transport of milk by pipe lines, says *Engineering and Industrial Management*, is under consideration in Germany. It has been ascertained by experiments that the method must be one of high pressure through relatively small pipes, and since the milk does not come in contact with air and bacteria, it is said to be immune from deterioration and the method absolutely hygienic. The obvious fear that casein may segregate and block the pipe line has been shown to be technically irrelevant, as no such deposits can form unless by some carelessness sour milk should be admitted into the pipe line, but even in such an eventuality the rinsing with an alkaline liquid would dissolve and remove such deposits. This matter has been taken up by the German Agricultural Society, and it is intended to convey the milk by such means from rural collecting centres to distributing depots in towns.

Rubber-Seed Oil in Sumatra.—After extensive investigations in Sumatra and the Federated Malay States, the conclusion has been reached, according to a report from the United States Consul in Sumatra, that it would not be to the advantage of the rubber plantations to collect seed specially for the purpose of extracting oil therefrom, and that Hevea seed would become profitable only in connection with oil from other products. At present there is no machinery for extracting this oil on the rubber estates, and the Director of the Experiment Station is of opinion that it would not pay to install such machinery unless other oil-bearing seeds could be produced in the same locality. Nor would it be considered profitable to export the seeds, as the bulk is great in proportion to the small content of oil.

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FRIDAY, SEPTEMBER 24, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

INDIAN SECTION.

SPECIAL MEETING.

On FRIDAY, OCTOBER 15th, MR. THOMAS M. AINSCOUGH, O.B.E., His Majesty's Senior Trade Commissioner in India and Ceylon, will read a paper on "British Trade with India."

The chair will be taken at 4.30 p.m. by SIR CHARLES C. MCLEOD.

INCREASE OF SUBSCRIPTION.

At the Annual General Meeting, held on June 30th, it was unanimously resolved that the annual subscription of Fellows be increased from £2 2*s.* to £3 3*s.*, and the Life Composition fee from £21 to £31 10*s.* The new scale will apply to all subscriptions due on and after Michaelmas, 1920.

These changes have been necessitated mainly by the great increase in the cost of the *Journal*, which rose from £1,767 4*s.* 11*d.* in 1913–14 (the last year before the war) to £2,851 11*s.* 10*d.* in 1919, and will probably rise further to about £3,800 for the current year. The general costs of maintenance and of conducting the work of the Society have also inevitably risen. Further particulars as to the financial position of the Society were published in the report of the Annual General Meeting in the *Journal* of July 2nd.

COLONIAL SECTION.

The Colonial Section Committee, as appointed by the Council, is as follows:—

Alan A. Campbell Swinton, F.R.S. (Chairman of the Council).
Lord Blyth (Chairman of the Committee).
Marquess of Aberdeen and Temair, P.C., K.T., G.C.M.G., G.C.V.O.
A. H. Ashbolt (Agent-General for Tasmania).
Sir Charles H. Bedford, LL.D., D.Sc.
Byron Brenan, C.M.G.
Richard Ernest Brounger.
Sir William H. Clark, K.C.S.I., C.M.G.
Sir Dugald Clerk, K.B.E., D.Sc., F.R.S.
Hon. James Daniel Connolly (Agent-General for Western Australia).
Hon. Sir John A. Cockburn, K.C.M.G.
Sir Edward Davson.
Edward Dent, M.A.
Sir Walter Egerton, K.C.M.G., LL.D.
Right Hon. Andrew Fisher (High Commissioner for Australia).
W. L. Griffith.
J. McEwan Hunter (Agent-General for Queensland).
Lord Inchcape, G.C.M.G., K.C.S.I., K.C.I.E.
Hon. J. G. Jenkins.
Major Sir Edward Humphrey Manisty Leggett, R.E., D.S.O.
Hon. Edward Lucas (Agent-General for South Australia).
Hon. Sir Peter McBride (Agent-General for Victoria).
Sir George Robert Parkin, K.C.M.G., M.A., D.C.L., LL.D.
Sir Westby B. Perceval, K.C.M.G.
Sir Robert W. Perks, Bt.
Hon. Sir George Halsey Perley, K.C.M.G. (High Commissioner for Canada).
Right Hon. Sir Joseph West Ridgeway, G.C.B., G.C.M.G., K.C.S.I.
Lieut.-Colonel Sir Thomas Bilbe Robinson, G.B.E., K.C.M.G.
Lord Sanderson, G.C.B., K.C.M.G.
Sir Thomas Sutherland, G.C.M.G., LL.D.
Carmichael Thomas.
George Wilson, C.B.
Sir Frederick W. Young, M.P.
S. Digby, C.I.E. (Secretary).

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

RECENT RESEARCH IN CELLULOSE INDUSTRY.

By CHARLES FREDERICK CROSS, B.Sc., F.R.S.

Lecture I.—Delivered February 16th, 1920.

LIGNOCELLULOSE TYPES.

The subject of the present essay is a perennial source of interest to a very wide and varied range of readers and workers; it is so in the nature of things, and for reasons so fully recognised, as to require only this bare comprehensive mention by way of preface, with an illustration which, if personal, is apposite. It is just forty years since the publication of a paper on the "Chemistry of Bast Fibres," recording the results of the early work of my partner Mr. E. J.

Bevan and myself in this field, a tentative essay communicated to our fellow-students of the Owen's College Chemical Society (April, 1880, Chem. News, 42, 77).

In this essay, establishing some fundamental quantitative relations of lignone and cellulose in the jute fibre (lignocellulose), we made mention of a phenomenon well known in the jute industry, the destructive damage of the fibre which occurs from time to time in the press-packed bales in course of transit from India and storage, and is known as "heart damage."

The chemical constitutional features of this structural breakdown were more fully dealt with in a later paper (J. Chem. Soc., 1882, 41, 90). It did not require much imagination to recognise in this phenomenon, and its attendant results, an opening of the science of the subject from the "natural" side, and therefore with promise of fuller revelation of constitutional factors than by way of laboratory methods of resolution by reagents. Further, there was and is, a very obvious industrial-commercial aspect of the matter, involving as it does, material values and business interests.

But the "interests" were not interested, and "science" was preoccupied with the intensive following up of its systematic developments. Moreover, the authors were feeble folk, or student adventurers on the ocean of knowledge, and so the opportunity was pigeonholed.

About the year 1907, the matter was revived, but from the more "practical" side, presumably an epidemic of "damage," and we were asked by the Indian Government to investigate the matter from this point of view.

In association with Mr. Finlow, the Government fibre expert, these investigations have been mainly directed to establishing the range of "normal" moisture within which the fibre in the press-packed condition of the commercial bale is immune from damage under the ordinary conditions of transport and storage. The results are recorded in two reports, printed and circulated by the Government Department. In the one (Cross and Bevan, 1908), the chemistry of the damage is further elucidated, and in the other (R. S. Finlow, Memoirs, Dept. Agr., India, Vol. v, No. 2, 1918) it is finally established:—(1) That the limit of moisture beyond which there is liability to the particular damage is at 25-30 per cent., the limit varying with the degree of compression of the fibre in the bales; (2) that the active agency in initiating the breakdown of the fibre substance is bacterial development; (3) that the mould growths, which are a frequent visible evidence of the "organic" nature of the damage, are a secondary effect, due to the breakdown products providing a nutrient medium for growths. The more prevalent organism of this class has been identified as *Aspergillus fumigatus*.

We mention this matter by reason of the typical significance of its history. During a period of forty years a problem of far-reaching scientific importance, and of obvious practical incidence, has been able to inspire two officially delimited investigations, limited, that is, to the latter which is the "practical" commercial issue. By contrast, the issues involved on the scientific side are of wide and presumably absorbing interest:—

(1) The chemical constitution of the fibre substance, cellulose and lignone, and their mode or condition of union as lignocellulose.

(2) The equilibrium of the lignocellulose system in relation to water, oxygen, micro-organisms, and the forms of energy which are operative in the organised system of the plant, and in modified degree after separation from the plant.

(3) The structural modification of fibres and tissues determined by lignification, and the correlative variation of (2) with degree of lignification.

These primary problems have been the subject of detached investigation during the period 1880-1920, the more important of which are described in "Researches on Cellulose" (Cross and Bevan, 1895–1910), and subsequently in "Lignone Reactions and Constitution" (J. Soc. Dyers, Col. 32, 1916).

In view of the special purpose of these lectures, it is necessary to assume that audience and readers have more than general knowledge and interest in the subjects treated, in order to give prominence to a rather "impressionist" survey, with indications of the sectional research fields, innumerable, which await the workers of this generation.

On the other hand, to attempt a systematic or encyclopædic treatment would sacrifice an opportunity in conforming with the convention of the prosaic order of the text books.

It appears that in the present phase of re-discovery, even the journalist order of mind is awakened to the importance of "cellulose," the textile fibres, the more massive products of plant life, and the colossal interests which may be connoted.

As to the complementary perceptiveness of their prospective relationship to natural science,

it would appear from the constitution of industrial research associations, under Government auspices, that the official mind is awakened to the country's systematic neglect of the obviously genetic relations of science to progressive industry. But it is doubtfully alive to the more positive philosophy of the matter, which may be summed up in a paraphrase: "Take thought of science, and all those things shall be added."

The further consideration of some aspects of the lignocellulose problems is thus intended to be suggestive of prospective developments.

The lignone component is a complex of which, as constituent groups, there have been diagnosed a diketo-hydrobenzene, a hydro-pyrone, and ketene ($-CO-CH_2-$) molecules, *i.e.*, residues (J. Soc. Dyers, Col. 32, 1916).

The union of lignone with cellulose to constitute the lignocellulose is now accepted to be of the order of adsorption compounds.

The intimate association of the saturated polyhydroxy cellulose group with the unsaturated lignone complex, suggests a system capable of interior exothermic rearrangements.

The investigation of the heart-damaged jute, reveals such changes to new complexes without changes of elementary composition. The characteristics of the water soluble products are acidification, definite transitions to aromatic hydroxy derivatives, and to derivatives which appear to be keto-aldehydes.

Accepting such evidences as the basis of working hypotheses, they provide a *point d'appui* for the investigation of the issues above formulated.

Grouped with these are other physiological problems, *e.g.*, the origin of the lignone complex, and its relation to the tannins and such aromatic complexes—phenol-pyrone derivatives—as are characteristic of the dye-woods. Nor can we overlook, in the sense of taking for granted, the structural modifications characteristic of lignification. Lignified fibres and tissues are relatively rigid and inelastic. Moreover, lignification of fibre cells is invariably associated with units of small dimensions.

The problems of these relations have been in the field of investigation for many years, but workers have been waiting for opportunity or inspiration. As an illustration, attention may be directed to a recent Royal Society paper by Professor Robinson (Nov. 1919). Investigating the effects of strain upon wood structures, such as are used in aeroplane construction, he has shown that deformation under pressure is attended with de-lignification, a separation of cellulose from lignone. Also, that the lignocellulose behaves as a fluid or liquid system. These points we shall refer to in a subsequent lecture. The immediate objective of this investigation was obviously technical, but the result was recognised as a contribution to pure science. This is worthy of incidental mention in illustration of a general trend. Industry and manufacture are teeming with research problems. The problems are many, but the science is one.

Professor Robinson investigated a detached problem and the scientific results are closely co-ordinated with progressive work on apparently quite independent lines of research.

Thus an adsorption compound of lignone and cellulose is obviously open to fractional resolution, by physical process. The result under discussion is a confirmation of this more recent theory of lignocellulose matter.

The fluid characteristics of lignocellulose emphasised by Professor Robinson's observations, accord with our observations in various directions converging in the inference that the vegetable fibre substances are to be regarded as liquid systems (J. Soc. Dyers, Col. 35, 1919, 270), characterised by considerable volume changes under reaction with water, and also with changes of temperature, on which view the intimate interpenetration of the cellulose and lignone systems in the histological processes of formation is brought a step nearer to our comprehension, with suggested lines of investigation.

But the problems of the more advanced type of lignification, characteristic of the perennial woods, are much more complex than those of annual crop plants. In this region also there are well-known processes of breakdown, under the attack of organisms, which urgently call for systematic study, since the products must represent new equilibrium phases of the component groups.

In the middle period of our research work in this field we were in active correspondence with Professor Crié, at that time of Rennes University, who was appointed by the French Government to study the phenomena of decay of forest trees (*Dépérissement des Arbres*). We examined several specimen products; characteristic results in particular cases were:—

(*a*) A pine wood:—

Moisture in air dry state . . .	10·0
Soluble in 1 per cent. NaOH .	98·3
Furfural	0·8

(*b*) A hazel wood, with patches of a bright blue colouring matter, soluble in alcohol.

The alcoholic solution contained a notable proportion of aromatic compounds with reactions of the gallo-tannins.

(*c*) An oak wood, in an advanced condition of disintegration, with a high proportion of water-soluble derivatives. The residue from exhaustive treatment by water was quantitatively investigated, and the main chemical constants were closely similar to those of the original wood substance. Whereas wood substance is evidently endowed with extraordinary resistance to destructive breakdown, it is equally evident that a change of condition, slight in regard to calculable chemical effect, initiates down-grade modifications.

A case in point, also noteworthy as arising in connection with industries, is the breakdown of "mechanical" wood pulp stored in the moist condition. Although by no means a rare occurrence it has been little investigated. In 1908, following our report (*supra*), we received a communication of details of an investigation of "rotten" wood-pulp from Mr. F. Barnes, at that time chemist to Messrs. Ed. Lloyd and Co., Ltd.

The degradation of the pulp affected massive quantities, 4 cwt. bales were found to be attacked throughout.

It was noted that these extreme effects were in bales in the middle of the stacks of pulp, therefore, in the words of Mr. Barnes's note, "the whole stock may be considered as one bale," and this suggestively links the observations and investigations with the "heart damage" of jute lignocellulose in the bale.

The following important points were established:—(1) Particular sheets of pulp were made up of (*a*) white undamaged pulp; (*b*) grey and rotten pulp; (*c*) red-brown and rotten.

Water Soluble Compounds in (a) 1·0 to 2·0 per cent., had become 14·0 to 25·0 per cent. in (*b*) and (*c*) with the high "sugar" value (cupric reduction) of 30 to 40 per cent.

Furfural Constants in (*a*) 4·4 per cent.: in the *water-soluble*, from (*b*) and (*c*) similarly 4·4 per cent of total dissolved substance, whereas in the original specimens of degraded lignocellulose, the percentages were in (*b*) 2·5, in (*c*) 2·12.

The chemical changes in the complex are of exactly the same order as in the "annual" lignocellulose.

There are obvious inferences from these observations. The papermaker's loss is the agriculturalist's prospective gain. Cellulose "degradation" is the obvious preparation for assimilation, *i.e.*, re-assimilation.

The economic questions arise:—(1) in which direction would such matter be more advantageously used, as plant food or as a nutrient for animals?

(2) If usefully available, how can the transformation be industrially worked on one of the world's gigantic wastes, sawdust, and the many similar rejecta of the wood working industries?

Incidentally to this discussion there must be mentioned:—

(1) Recent developments in the utilisation of wood cellulose as cattle food (J. Soc. Chem. Ind. 37 (1918), 437 R).

(2) A process for treating wood residues to transform the lignocellulose into assimilable material which was worked for some time in this country, the product being used as a component of cattle food mixtures, sold under the trade name of "Bastol."

The process is known as the "Classen" process (H. Classen, in U.K. Pat. 12588 (1901); J.S.C.I., 1901, 1008).

The active agent used was sulphurous acid, applied in an atmosphere of steam to the sawdust contained in a digestor. By the treatment a proportion of the lignocellulose, about 20 per cent. was brought into water soluble form, with a high "sugar" value.

It was claimed for the remainder that though insoluble it was nevertheless for the most part assimilable in the digestive tract of the animal.

It would be outside the scope and purpose of these lectures to press this discussion to any formal conclusion. We are dealing with undeveloped lines of investigation converging in a main suggestion, that the more resistant lignocelluloses are capable of transformation to proximate products of industrial value. The transformations already investigated involve the "destruction of material used, and valuable for structural purposes." From the point of view of the industries involved they are "damages"; from the complementary point of view of other industries they are constructive transformations.

A special type of lignocellulose and lignification is presented by another of our staple industrial raw materials, viz., esparto grass. The grass is highly complex, both as a structure and an assemblage of products. The following results of later investigations have their obvious and direct technical value, and open up the

more scientific problems of constitution in specific terms.

These investigations have been carried out by our friend J. F. Briggs, and we are indebted to him for the communication of results.

Spanish Esparto was heavily crushed between steel rollers to open up the tissues to penetration by liquids. Boiled in water there is a progressive "extraction" of water-soluble products; in 2 to 4 hours, 8·4–10·9 per cent. calculated to dry substance.

Following this treatment, digestion in 1 per cent. NaOH for forty-eight hours in the cold, removed a further 25·8 per cent.

Determination of lignone by the phloroglucinol-absorption method (Cross and Briggs):—

	Per cent.	
On original grass gave	6·75	$C_6H_3(OH)_3$ absorbed in combination with lignone
Water-extracted grass gave	5·36	
Water and Soda-extracted grass gave	4·02	

The lignone components of the grass are, in part, much more sensitive to attack than in the case of the typical jute; applying the generally adopted specific treatment, viz., with 72 per cent. H_2SO_4 for isolating the lignone, the water-extracted grass yielded (*a*) 18 per cent., (*b*) 18·6 per cent.

Sfax Grass treated comparatively gave the following results:—

Soluble, three hours boiling with water	13·25 per cent.
Phloroglucinol absorbed by water-extracted grass	9·5 ,, ,,
Lignone residue (H_2SO_4 process)	26·5 ,, ,,

Further observations in development of the above tend to the general conclusions:—

In alkali "extracts" of the grass the lignone is in union with a carbo-hydrate colloid. The union of these is readily resolved on boiling the alkaline extract. Much of the lignification of the grass is a definite incrustation, *i.e.*, external to the fibres proper, the reactions of which are those of cellulose.

The esparto grass, though highly lignified, as shown by the phloroglucinol constants, is resolved to cellulose and soluble derivatives of non-celluloses, under the condition of the industrial treatments which are less severe than those required for the woods. The above observations give the rationale of differentiated treatment, not only for these extreme cases, but also for the varying grades of the esparto grass in ordinary paper mill practice.

From the by-product liquors of treatment of the grass in our paper mills, the lignone and colloidal carbohydrates are separated and isolated in the laboratory by a first treatment with 1·4 vol. 90 per cent. alcohol.

The lignone as lignic acid (soda salt), is soluble in the resulting dilute alcohol, and is obtained from the mother liquor, after removing the alcohol, by acid precipitation. The carbohydrate is washed with alcohol of the same dilution, and is obtained as a colourless body, retaining some soda (1·0 per cent. NaOH). This may be eliminated by further purification. The carbohydrate gives the high yields of furfural (40 to 45 per cent.) characteristic of the pentosanes. The proportions of these specific bodies recovered by the process are:—

	Spanish. Per cent.	Sfax. Per cent.	
Carbohydrate	9·0	10·0	Calculated to the original dry grass.
Lignic acid	12·0	15·0	

The lignic acids have the soda equivalent $100 = 7{\cdot}4\ Na_2O$.

It appears from these investigations that the lignone components of the grass tissues are a mixture of compounds conforming with the general type, differentiated or graduated in respect of resistance to hydrolysis.

It is clear that an exhaustive study of esparto as a chemical-biological subject or object would throw much light on the mode of elaboration of lignone, and the function of this group of unsaturated hydrobenzene derivatives in the plant.

Such investigations are much facilitated by the availability of raw material, and by-products of treatment, in indefinite quantity. This is generally true of the raw materials of our massive industries. It is further obvious that such materials have passed into industry, as staple products, on the basis of a "selection" from a large number of types which were *a priori* possible competitors.

Survival justifies the selection, and the student is well advised on these comprehensive grounds to give preference to such selected and established natural products as subject matter for research. There is always, moreover, with such products, the prospect or certainty of contributing something to technical progress.

In conclusion, we mention a type of water-soluble colloidal lignone complex, which characterises certain fruits, and notably the white currant, from which it was first isolated for investigation by Tollens (de Haas and Tollens, Annalen, 286 (1895) 278), and later, was further investigated to establish its identity as a com-

plex of unsaturated lignone groups, and saturated carbo-hydrate groups of the "pectic" type (C. F. Cross, Berl., Ber., 28 (1895), 2609).

On the general constitutional relations of the "Pectic" carbo-hydrates and the importance of these plant-tissue constituents, mention must be made of recent researches by F. Ehrlich (Chem. Ztg. 41 (1917), 197).

In physical properties the perennial woods certainly appear to be far removed from a fruit-colloid; but the divergence is only in external characteristics, and in the types selected for this *exposé*, there is an evident gradation.

Actually, wood substance proper is capable of re-hydration under the mechanical action of a paper-maker's beater; a fibrous wood-pulp being converted into a gelatinous mass, which dries to a coherent solid. The extreme divergence of a dense wood from a fruit-colloid as forms of matter is therefore only one of external characteristics.

This brief review of an aspect of a profoundly important chapter of natural history, should impress our "latter day" students of biochemistry that their world is very young and fresh, and that the investigations of the past fifty years, while laying out the lines of proximate progress, have exhausted no section of the subject.

THE ECONOMIC CONDITION OF EUROPE AFTER THE GREAT WARS OF A CENTURY AGO.*

In 1815 France had been engaged in almost continuous wars for twenty-three, England for twenty-two, years. The German States had been at war less continuously; but they had been fought over, conquered, and occupied by the French. Prussia, for instance, was overthrown in 1806. When the final struggle against Napoleon began, in 1812, there was a French army of occupation of nearly 150,000 men in Prussia alone. From 1806 to 1814 Napoleon's attempt to exclude English trade from the Continent had led to the English blockade—with its striking resemblances to, and its striking differences from, the blockade of 1914-19. Warfare was less horribly intense, and so less economically destructive, than it has become in our day; but what it lacked in intensity it made up in duration.

Take, for instance, the loss of life. For England it was relatively small—because for us the wars were never people's wars. In France also it was relatively small in the earlier years, when armies of the old size were mainly employed. But under Napoleon it became enormous. Exact figures do not exist, but French statisticians are disposed to place the losses in the ten years that ended with Waterloo at fully 1,500,000. Some place them higher. As the population of France grew about 40 per cent. between 1805-15 and 1904-14, this would correspond to a loss of, say, 2,100,000 on the population of 1914. The actual losses in 1914-18 are put at 1,370,000 killed and missing; and I believe these figures contain some colonial troops.

Or take the debts accumulated by victors and the requisitions or indemnities extorted from the vanquished. The wars of a century ago left the British debt at £848,000,000. According to our success or failure in securing repayment of loans made to Dominions and Allies, the Great War will have left us with a liability of from eight to nine times that amount. Whether our debt-carrying capacity is eight or nine times what it was a century ago may be doubted, and cannot be accurately determined. But it is not, I would venture to say, less than six or seven times what it was, and it might well be more. A good deal depends on future price levels. At least the burdens are comparable; and we understand better now where to look for broad shoulders to bear them.

After Waterloo, France was called upon to pay a war indemnity of only £28,000,000, to be divided among all the victors. With this figure Prussia was thoroughly dissatisfied. Not, I think, without some reason. She reckoned that Napoleon had squeezed out of her alone, between 1806 and 1812, more than twice as much—a tremendous exaction, for she was in those days a very poor land of squires and peasants, whose treasury only received a few millions a year. England, who was mainly responsible—and that for sound political reasons—for the low figure demanded of France, found herself, the victor, in the curious position of being far more heavily burdened with debt than France, who had lost. England, of course, had acquired much colonial territory; but on the purely financial side the comparison between her and France was most unequal. England's total national debt in 1817 was £848,000,000. France's debt did not reach £200,000,000 until 1830.

The reasons why France came out of the wars so well financially were four. *First*, she had gone bankrupt during the Revolution, and had wiped out most of her old debt. *Second*, under Napoleon she had made war pay for itself, as the case of Prussia shows. *Third*, there was no financial operation known to the world in 1815 by which England's war debt, or even half of it, could have been transferred to France. *Fourth*, England never suggested any such transference, or, so far as I know, ever even discussed it.

France's financial comfort, immediately after her defeat, extended to her currency. During the Revolution she had made a classical experiment in the mismanagement of credit documents, with the assignats issued on the security of confiscated Church property; but after that she had put her

* Extracted from the Presidential Address of Mr. J. H. Clapham, C.B.E., Litt.D., to the Section of Economic Science and Statistics, British Association, Cardiff.

currency in good order. Her final defeat in 1812-14, and again in 1815, did not seriously derange it. Indeed, the English currency was in worse order than the French, owing to the suspension of cash payments by the Bank of England; and so rapidly did France's credit recover after 1815 that in 1818 French 5 per cents. stood at almost exactly the present-day price of British 5 per cent. War Loan. That year she finished the payment of her war indemnity, and the last armies of occupation withdrew.

She had no doubt gained by waging war, and eventually suffering defeat, on foreign soil. No French city had been burnt like Moscow, stormed like Badajoz, or made the heart of a gigantic battle like Leipzig. Napoleon fought one brilliant defensive campaign on French soil, in the valleys of the Marne and the Seine, in 1814. In 1815 his fate was decided in Belgium. Hardly a shot was fired in France; hardly a French cornfield was trampled down. But France, as in 1918, was terribly short of men, and, again, as in 1918, her means of communication had suffered. Napoleon's magnificent roads—he was among the greatest of road engineers—had gone out of repair; his great canal works had been suspended. These things, however, were soon set right by the Government which followed him.

France's rapid recovery brings us to one of the essential differences between Western Europe a century ago and Western Eurcpe to-day. In spite of Paris and her other great towns, the France of 1915 was a rural country, a land of peasants and small farmers. Only about 10 per cent. of her population lived in towns of 10,000 inhabitants or more. The town below 10,000, in all countries, is more often a rural market town, utimately dependent on the prosperity of agriculture, than an industrial centre. Parallels for France's condition must be sought to-day in Eastern Europe—in Serbia or Russia. It is a condition which makes the economics of demobilisation easy. The young peasant goes back from the armies to relieve his father, his mother, and his sisters, who have kept the farm going. Moreover, France maintained a standing army of 240,000 men after 1815; and her losses in the Waterloo campaign had been so heavy that the actual numbers demobilised were relatively small. Demobilisation left hardly a ripple on the surface of her economic life.

The German states were far more rural in character even than France. There were a few industrial districts, of a sort, in the West and in Saxony; a few trading towns of some size, like Hamburg and Frankfurt; but there was nowhere a city comparable to Paris. In 1819 the twenty-five cities which were to become in our day the greatest of the modern German Empire had not 1,250,000 inhabitants among them. Paris alone at that time had about 700,000. German statesmen, when peace came, were occupied not with problems arising from the situation of the urban wage-earner, though such problems existed, but with how to emancipate the peasants from the condition of semi-servility, in which they had lived during the previous century. Here, too, demobilisation presented few of the problems familiar to us. Probably not one man in ten demobilised was a pure wage-earner. The rest had links with the soil. The land, neglected during the war, was crying out for labour, and every man had his place, even if it was a servile place, in rural society.

Things were different in England; but our demobilisation problem was smaller than that of our Continental allies or enemies, who had mobilised national armies, though not of the modern size. On the other hand, we had kept an immense fleet in commission, the crews of which were rapidly discharged. Early in 1817 Lord Castlereagh stated in Parliament that 300,000 soldiers and sailors had been discharged since the peace. In proportion to population, that would be equivalent, for the whole United Kingdom, to nearly 750,000 to-day. For these men no provision whatever was made. They were simply thrown on the labour market; and the vast majority of them were ex-wage-earners or potential wage-earners, industrial, mercantile, or agricultural. The United Kingdom was not urbanised as it is to-day; but the census of 1821 showed that 21 per cent. of the population lived in cities of 20,000 inhabitants and upwards, and probably about 27 per cent. (as compared with France's 10 per cent.) lived in places of 10,000 and upwards. As industry in various forms, especially coal-mining, spinning, and weaving, was extensively carried on in rural or semi-rural districts, it is certain that at least one demobilised man of working age in every three was a potential wage-earner of industry or commerce. And as Great Britain had lost most of her peasant-holders, whether owners or small working farmers, the remainder of the demobilised rank and file were nearly all of the argricultural labourer class. They had to find employment; there was not a place in rural society waiting for them, as there was for the average French or German peasant soldier. It is not surprising that the years from 1815 to 1820 were, both economically and politically, probably the most wretched, difficult, and dangerous in modern English history.

Things were at their worst in 1816-17, both for England and for her continental neighbours. Western Europe was very near starvation. Had the harvest of 1815 not been excellent, so providing a carry-over of corn, or had the harvest of 1817 been much below the average, there must have been widespread disaster; so thorough and universal was the harvest failure of 1816. In the latter part of 1815 (December) wheat fell in England to 55*s.* 7*d.*, although no grain imports were allowed, except of oats. Early in 1816 the United Kingdom was actually exporting a little wheat. Then came a terrible spring—a long frost; snow lying about Edinburgh in May; all the rivers of Western Europe in flood. An equally disastrous summer followed. There was dearth, in places amounting

to real famine, everywhere — worst of all in Germany. Unlike France, the German States of a century ago were extraordinarily ill-provided with roads. What roads there were had gone to pieces in the wars. In winter even the mails could hardly get through with sixteen and twenty horses. Food supplies could not be moved over long distances by land; and the slightly more favoured regions could not help the most unfortunate. There was a far wider gap between prices in Eastern and Western Germany in 1816 than there had been in the last bad famine year (1772). Each German State, in its anxiety, began to forbid export early in 1816, thus making things worse. At Frankfurt, the representatives of the German States, gathered for the Diet, could hardly feed their horses. Prices rose amazingly and quite irregularly, with the varying food conditions of the various provinces. In the spring of 1817 pallid half-starved people were wandering the fields, hunting for and grubbing up overlooked and rotten potatoes of the last year's crop.

In England the harvest failure of 1816 drove wheat up to 103*s.* 7*d.* a quarter for December of that year, and to 112*s.* 8*d.* for June of 1817. In Paris the June price in 1817 was equivalent to 122*s.* 5*d.* At Stuttgart the May price was equivalent to 138*s.* 7*d.* These are only samples. Think what these figures mean at a time when an English agricultural labourer's wage was about 9*s.* 6*d.*, and a French or German unskilled wage far less. It must be recalled that there were no special currency causes of high prices either in France or Germany. These were real dearth prices. In the spring of '17 the French Government was buying corn wherever it could find it—in England, North Africa, America—as another bad harvest was feared. Happily, the 1817 harvest was abundant, here and on the Continent. By September the Mark Lane price of wheat was 77*s.* 7*d.*, and the Paris price 71*s.* 9*d.*

I have gone into price details for the purpose of drawing a contrast between a century ago and to-day. Except for the damage done to the German roads, the wars had very little to do with these food troubles of 1816–17. High and fluctuating food prices were the natural consequence of the general economic position of Western Europe a century ago. It was only in the most comfortable age in all history—the late nineteenth and early twentieth centuries — that low and stable food prices came to be regarded as normal. In the eighteenth century, when England fed herself and often had an exportable surplus, fluctuations were incessant. Take the ten years 1750–1760. The mean price of wheat at Eton in '52 was 45 per cent. above the mean price in '50. The mean price in '57 was nearly 100 per cent. above the mean price of '50. On Lady Day '57 the price was 60*s.* 5¼*d.* On Lady Day '59 it was 37*s.* 4*d.* On Lady Day '61 it was 26*s.* 8*d.* The '61 mean price was exactly half the '57 mean price.

Eighteenth-century England was too well organised economically to be in much risk of actual famine, but for Ireland and large parts of the Continent famine was a normal risk. War and its effects had only accentuated, not created, that risk. Imports might reduce it, but could not avert it, because Western Europe tends to have approximately the same harvest conditions throughout, and it was impossible to draw really large supplementary supplies from anywhere else. So unimportant were overseas supplies that the Continent suffered very much more from the harvest failure of 1816, in time of peace, than from the eight years' English blockade in time of war. If overseas supplies could be got they were hard to distribute, owing to defective transport facilities. Thanks to the work of the nineteenth century, the most terrific of all wars was required to bring Western Europe face to face with what had been both a war-time and a peace-time risk a century earlier.

But the old Europe, if it had the defects, had also the elasticity of a rather primitive economic organism. Given a couple of good harvests, and a land of peasants soon recovers from war. Serbia had a good harvest last year (1919), and was at once in a state of comparative comfort, in spite of her years of suffering. A second good harvest this year, for which fortunately the prospects are favourable, would almost restore her. So it was with France and, to a less extent, Germany in 1816–18. In France acute distress in 1816–17 had been confined to the towns and to those country districts where the harvest failure was worst. The harvest of '17 put an end to it. One gets the impression that in Germany distress among the peasants themselves had been more widespread. Worse communications and the absence of a strong central Government seem to have been the chief causes of this, though perhaps the harvest failure was more complete. In France, as we have seen, the central Government took such action as was possible in the interests of the whole country. A parallel might be drawn between the German situation in 1815–17 and that of the States which have arisen from the break-up of the old Austro-Hungarian Empire since 1918. Freed from French domination, and then from the urgent necessity of co-operating against a common enemy, the German States relapsed into their ancient jealousies and conflicting economic policies, just as the new States, which were once subject to the Hapsburgs, have been forbidding exports of food and fuel and disputing with one another.

An excellent harvest in 1817 averted the risk of famine in Germany also; but anything that could be called prosperity was long delayed, whereas France was indisputably prosperous, judged by the standards of the day, and far more contented than England, by 1818-20. Germany had been so exhausted by the wars and incessant territorial changes of the Napoleonic age, and was politically so divided, that her economic life remained stagnant and her poverty great until at least 1830. It was all that the various governments could do to find money for the most essential of all economic measures—the repair and construction of roads—

whereas France had her splendid main roads in order again and had resumed work on her canals before 1820. But France had cut her losses nearly twenty years before, and had enjoyed continuous freedom from war on her own territory between 1794 and 1814, as we have seen. She had been well, if autocratically, governed, and her war indemnity was but a trifling burden. Her peasants were free and, as a class, vigorous and hopeful. She was united and conscious of her leadership in Europe, even through her ultimate defeats.

If the experience of Europe after Waterloo is, on the whole, of good augury for agricultural States, and especially for agricultural States with a competent central Government, for the industrialised modern world that experience is less encouraging. Great Britain alone was partially industrialised in 1815-20, and Great Britain, though victorious, suffered acutely. Mismanagement was largely responsible for her sufferings—mismanagement of, or rather complete indifference to, problems of demobilisation; mismanagement of taxes (the income tax was abandoned at the clamour of interested parties, and the interest on the huge debt paid mainly from indirect taxes, which bore heavily on the poor); mismanagement of food supplies, by the imposition of the Corn Law; and so on. But suffering due to international economic dislocation following war could not have been avoided by management, however good. The situation was unique. England alone of the European Powers had developed her manufactures to some extent on what we call modern lines. During the wars she had accumulated also great stores of colonial and American produce, which could only get into Europe with difficulty — by way of smuggling. In 1813, before Napoleon's first fall, her manufacturers and merchants were eagerly awaiting peace. In 1814 manufactures and colonial produce were rushed over, only to find that, much as Europe desired them, it could not pay the price. It had not enough to give in exchange; and England, being rigidly protectionist, was not always prepared to buy even what Europe had to give. There was no machinery for international buying credits. Merchants shipped at their own risks, usually as a venture, not against a firm order as to-day, and they had to bear their own losses—often up to 50 per cent. Continental economic historians have hardly yet forgiven us for this "dumping," which both drained away the precious metals to England—as there was not much else to pay with—and did a great deal of harm to the struggling young factory industries, which had begun to grow up under the protection of Napoleon's anti-English commercial policy.

THE OIL PALM IN NIGERIA.

The exploitation of the oil palm is still essentially a native industry in Nigeria, though, according to a note by the Comptroller of Customs at Lagos, published in the *Board of Trade Journal*, two European enterprises are now extracting oil within the country. The operations of one company have been so successful that they propose to extend their operations to new districts at an early date.

It is said that oil palms are actually planted by the native, but if so it is on a very small scale. What happens is that natural seedlings, of which millions grow and perish annually, are left "unweeded" when clearings are made for farms, and are thus able to survive owing to the diminished danger of being smothered by more vigorous weeds. Such seedlings as are thus accidentally protected are likewise accidentally cultivated, getting the benefit of the little cultivation given to the other crops on the farm. It is commonly stated by natives that oil palms on such farms are more prolific than bush palms, which is extremely probable. Growth and reproduction in wild palms is extremely slow, and whereas a deliberately cultivated palm begins to bear small bunches—of little value, it is true—at about the fifth or sixth year, it is not improbable that first fruiting is delayed ten or fifteen years in the bush, till the palms can get their heads exposed to free air and sunlight.

So far as is known, the oil palm is subject to no serious disease, but up country it suffers annually and severely by being swept by bush fires. It is not uncommon to see the oil-bearing bunches of fruits ablaze, and the whole crown severely scorched. Another serious menace is the tapping of the palms for toddy by the illicit method of stem (cabbage) incision, a method illegal amongst the people themselves, though now too frequently overlooked and left unpunished. Tapping the stem of the male inflorescence does little or no damage, though oil is lost by the cutting out of undeveloped fruiting bunches for the greater convenience of the tapper. Tapping is believed to be on the increase since the imposition of the heavy duties on imported spirits, but the evidence is not too conclusive. Further, it is, perhaps, and always has been, commoner in up-country districts, where the more economic exploitation of the palm for oil is not sufficiently profitable owing to the low prices for oil and kernels, which have to bear heavy transport charges to the coast. Wine-getting in such districts is a much more profitable business and less laborious than oil extraction, in consequence of which the only oil production of such places is for local consumption. A considerable quantity of kernels in such places are consumed in the native soap-making industry.

Need for Research.

Research is desirable on the keeping qualities of oils prepared in different ways. It is notorious that the pericarp oil which the native makes for his own consumption is of a better quality than what he takes to the European factory. It is more carefully prepared, and may be described as twice boiled. An extra boiling has often to be given at the buying factory—carried out by the seller—which, while it eliminates water, cannot affect the free acid content that has accumulated since the time of the

original preparation. The original extra careful straining and boiling carried out at the first preparation probably accounts for the superior quality of the oil which the native retains for his own consumption.

Need for Cheaper Machinery.

While the oil palm industry suffers like all others from insufficient and excessively expensive transport facilities, it has suffered most, perhaps, from a want of enterprise by the merchants in failing to put on the market cheap and sufficient nut-cracking machines, and perhaps, also, simple presses, but especially the former. This question is really one of great urgency with the discovery of new sources of vegetable oil in different tropical countries, and commercial development of the hydrogenation process which are now making low fish oils possible substitutes. Palm nut cracking by hand is laborious work, and serious competition of other oils might lead to a fall in price that would make local industry unprofitable. It has been said that a commercial use has been found for the shells, but no details have been published.

Copra.

The coconut palm, though abundant throughout the Southern Provinces—few villages being without some palms—has not been exploited for copra, except at one or two places on the coast. The climate up-country is admirably suited for copra production. The trees can stand the Harmattan, and the Harmattan could be used as a copra drier of the first order. The palms mature their main crop just about the time of the onset of the dry season. Nowhere is the coconut used as a source of toddy.

The only palm of economic importance—one which is indigenous to the country—is the wine palm (Raphia vinifera), which is a source of piassava fibre. Though the palm is extremely common, it has so far received little attention as a source of fibre.

Export of Palm Kernels, etc.

In 1919, 216,913 tons of palm kernels, valued at £4,947,995, were exported from Nigeria, compared with 205,167 tons, valued at £3,233,080, in 1918. Palm-oil exported weighed 100,967 and 86,425 tons in the same years, being valued at £4,245,893 in 1919, and £2,704,445 in 1918.

Ground-nut exports were 39,335 tons and 57,554 tons in 1919 and 1918 respectively, valued at £698,702 and £920,137.

Cola Nuts.

The Gold Coast variety of the cola nut can be successfully cultivated in many parts of the Southern Provinces. In some districts the farmers have found that it is even a more profitable crop to grow than cocoa. Each year about £200,000 worth of cola nuts is imported from the Gold Coast; efforts are, therefore, being made to encourage extensive cultivation of this crop. With this effort in view the Agricultural Department has, during the last two years, distributed about 73,000 cola seeds and 27,000 cola plants to farmers.

JAPANESE POTTERY INDUSTRY.

It is characteristic of Japanese ceramics that the numerous varieties have always been distinguished from one another geographically rather than technically. Thus Satsura ware, Imari ware, Awata ware, etc., names well known to foreign connoisseurs, refer to the districts in which the pottery is made. Indeed, the common Japanese word for pottery, "Seto-mono," is derived from the town of Seto, in Aichi-Ken, most famous of all for its wares, much as our word "China," is reminiscent of the country where the product originated.

Japanese wares may be classed roughly in three groups:—

1. Stoneware, including tiles and various utility objects, usually glazed and ornamented only by stamping or scoring, made in many parts of Japan and chiefly consumed locally.

2. Faience, such as Satsuma and Awata ware, most often with a crackle glaze, and highly decorated. It is not fired at so high a temperature as porcelain and is consequently softer and more fragile; but, for the same reason, more delicate colours may be used in decoration. Much of this sort of ware has found its way abroad under the designation of "curios."

3. Hard porcelain and semi-porcelain (Kutani among the coarser wares and Seto, Imari, and Kiyo midzu among the finer).

According to an interesting report on the Japanese pottery industry, by the United States Commercial Attaché at Tokio, the porcelain of Japan is made in a different way from that of China. Having been fashioned, it is baked in a biscuit state, then painted with such colours as require a great heat and the glaze applied, then burnt again at a much higher temperature; any further decoration in enamel colours or gilding is subsequently fired in a muffle kiln. These numerous firings are less tenacious than those used in China; hence Japanese specimens are frequently slightly out of shape.

The value of the porcelain and earthenware produced in Japan in 1918 was 44,214,084 yen (approximately £4,500,000). The relative production of the different classes of pottery for 1917 was as follows: Ornaments and art objects, 18 per cent.; dishes, 56 per cent.; industrial goods, 10 per cent.; toys, 5 per cent.; miscellaneous, 11 per cent.

In the years 1909-13 the value of the exports of pottery kept about the same figure, but from the beginning of the war the annual export steadily increased until the amount for 1918 had grown to nearly four times the figure for 1914. In the following table the total values of exports of pottery from Japan during 1913-18 are given.

	Yen.		Yen.
1913 . .	6,637,000	1916 . .	12,104,000
1914 . .	5,989,000	1917 . .	14,474,000
1915 . .	6,984,000	1918 . .	19,958,000

Yen = 2s. 0½d.

The following classes of porcelain and semi-porcelain products, which are produced in quantity, enter largely into the export trade, for which they are mainly manufactured: Tableware, including all the pieces comprised in ordinary dinner sets; sanitary ware, such as washbowls and other bathroom fixtures; electrical porcelain, such as insulators, sockets, etc.; and toys and novelties.

The earths used in the manufacture of commercial pottery may be divided into two general groups, technically known as kaolin and clay, the former being decomposed feldspathic matter contained in granite rock, and the latter being an alluvial deposit. Chemically they are similar, but physically they have different characteristics. In Japan is found a third variety, known as "rock clay" or "porcelain stone." This appears to be of similar construction to the kaolin, but decomposition has not gone to the extent of complete disintegration of the rock.

Kaolin for the potter's use is mined and washed in the same general manner in different parts of Japan. It is found in deposits in the high hills surrounding the town of Yamaguchi and is mined by tunnelling. The kaolin is loaded on small cars within the mine and run either to a dump at the mouth of the tunnel or directly to washing machines placed in buildings a few hundred yards distant. The kaolin is dumped on a platform and from there shovelled into a horizontal washing machine which consists of a barrel-shaped tub filled with water, about twelve feet long and six feet in diameter. Within this barrel is a revolving horizontal shaft to which arms are attached for the purpose of breaking up the mass.

The crude material as it comes from the mill consists of certain percentages of kaolin, quartz sand, and mica suspended in water. The particles are separated during the mixing process, and as they are discharged from the mixer the quartz, being heavier than the kaolin, is deposited in a vat or tank. The remaining kaolin and mica is then run through long troughs, which are divided into branches in order sufficiently to retard the flow of the mixture to permit the mica, which is lighter than the kaolin, to float off upon the surface of the water. The kaolin mixture is then run into large vats or tanks made of cement. The kaolin remains in suspension for a considerable time, but when sufficiently settled the surface water is drawn from the tanks and the residue pumped by hydraulic pumps into iron filter presses. As it leaves the presses the kaolin has the form of large circular cakes, similar in appearance to putty, which are placed on boards in open-air drying sheds or, in good weather, laid on racks exposed to the sun. When thoroughly dry these cakes are ready for market. In the Yamaguchi district the percentage of waste is extremely great, the actual amount of usable kaolin being only sixteen per cent. of the entire mass that comes from the mine.

The sand washings from this mass are used to a limited extent in the steel mills and in the manufacture of fire brick, but the great bulk is thrown on dumps unutilised.

The following analyses give an idea of the nature of the Japanese Kaolins and clays:—

Variety.	Percentage of—							
	SO_2.	Al.	Fe_2O.	Ca.	Mg.	K.	Na_2O.	H_2O.
Shiga-raki (Kyoto)	56·87	28·56	0·98	0·69	0·47	2·08	0·06	10·16
Owari (Seto)	54·65	32·35	—	0·90	0·37	3·27	2·22	6·30
Hizen (Arita)	49·25	38·89	1·14	0·15	0·36	2·01	0·39	5·90

Porcelain stone, which appears to be somewhat similar to our Cornwall stone, is believed to be produced by the action of solfataras upon volcanic rock (breccia). Great deposits are found in the Arita district, just north of Nagasaki. It is obtained from large quarries, and for local use is reduced chiefly by means of clumsy stamp mills run by water power, like those for milling rice. The material contains little or no mica; it consists of silicate of alumina in a physical condition between that of feldspar and kaolin, together with quartz sand, and is in itself capable of being made into chinaware without further admixture of other materials. Commercially, however, this is not practicable, because of the fact that the various percentages of ingredients are not uniform. It is also very susceptible to varying kiln temperatures, and has a limited range of fusibility.

The following table shows the analysis of various Japanese porcelain stones, as given by Rein, "Industries of Japan":—

Kind of Stone.	Percentage of—						
	SiO_2.	Al_2O_3.	FeO_3.	CaO.	KO.	Na_2O.	H_2O.
Arita stone I	78·70	14·27	1·16	0·45	2·24	—	3·29
Arita stone II	83·00	11·60	0·70	0·18	1·90	0·29	2·49
Amakusa stone	73·87	15·25	0·73	0·43	5·46	1·07	2·23
Kutani stone	76·60	14·75	0·86	0·29	3·91	0·65	2·68

All Japanese chinaware is made of one or more of the kaolins described above, but it has been found that English kaolin or china clay from Cornwall must be used to obtain the whitest and finest china.

Feldspar is found at the extreme northern and southern ends of the main island of Japan, but that from Fukushima is considered the best and gives the most satisfactory results. This is of excellent quality, and is delivered to the large pottery manufacturers in a crude state.

Saggars are fire-clay receptacles into which the ware is placed for burning. They are made of a crude fire-clay, the chief requirements being high refractory quality and great plasticity. The saggar clays of Japan are inferior to those found in America, the plasticity being below that required for the best results. As a consequence there is a much greater percentage of loss in firing; approximately forty per cent. of the saggars break in each firing. It is necessary to add some other material to counteract the excessive contraction of this clay under fire. In Japan, as elsewhere, the old cracked saggars are utilised for this, being broken up and coarsely ground to the size of a small pea as the maximum.

In the modern factories using the circular down-draft kilns a good quality of coal is required, which is difficult to secure in Japan. The coal used in the largest plant comes from Kyushu.

Plaster of Paris is perhaps one of the most important of the materials used indirectly in the manufacture of chinaware, since the moulds in which the ware is cast are composed entirely of it. It is manufactured locally, but its quality is such that for the best work imported material is used, and that is obtained from America.

The bulk of the decorating pigments and the finest colours come largely from England, formerly from Germany. The decalcomania sheets, which were formerly imported almost exclusively from Germany, are now coming principally from America. Some are being made in Japan, but it is likely that before long the domestic production will be displaced by the imported article. The costs are about three times the pre-war German price. Brushes are, of course, all of Japanese manufacture.

In the old-style Japanese potteries the glaze (called in Japanese "kusuri," a generic term for medicine) is compounded of carefully prepared clay paste mixed with wood ashes (usually oak and chestnut). The details of the mixture are usually held as trade secrets. In the modern factories the same sort of lead glaze is used as in Europe and America.

(To be continued.)

THE CARPET TRADE OF TIENTSIN.

It is only in recent years that Chinese carpets and rugs have been shipped abroad. At first only antique rugs were exported and eventually were all bought up. In 1912 American buyers on a visit to the Far East decided to send home small shipments of modern carpets. A demand for these carpets arose, which was accelerated in the early part of the war by the cutting off of the supply from Persia.

During the latter part of 1915 and early in 1916 such was the demand that prices rose until American buyers were paying at the rate of 2·75 to 3·50 Mexican dollars per square foot in Tientsin and Peking. As a consequence many new factories were started. The market in America became overstocked and prices dropped accordingly in China. Towards the end of 1916 and in 1917 it was possible to purchase good Chinese carpets of the 100-string quality at about 1·50 to 2 Mexican dollars per square foot. There was a large falling off in sales during 1917, which was partly due to the shortsightedness of the Chinese dealers and makers. The enormous demand from America experienced in 1916 tempted the weavers and dealers to endeavour to substitute an inferior article for the one stipulated. This was very soon detected by the buyers, and large quantities of the goods were thrown back upon their owners' hands, resulting in the closing down and ruin of many of the Chinese carpet dealing and weaving firms.

In the early part of 1918, principally on account of the American embargo, the local market prices dropped further until it was possible to purchase 100-string quality at about 1·20 Mexican dollars per square foot, and many factories were forced to close for lack of orders. In 1919, after the removal of the embargo, prices advanced. At present, writes the United States Consul-General at Tientsin, there are fewer factories than in 1916 and 1917, and consequently the production is much smaller. In fact, there have always been few actual factories. The manufacture is mostly a cottage industry and the work is carried on in the homes, where the families are often assisted by paid workmen. There are about as many factories in Tientsin as in Peking, though the best factory is in the latter city.

Chinese carpets for the American trade are usually turned out in 100, 90, 80, and 70 string qualities. At present Chinese vegetable dyes are used chiefly, owing to the high cost of the imported product. Heretofore imported dyes were preferred, as they were easier to work, and could be depended upon to give uniform results. In the Chinese dyes for the most part the colour lasts well, but it is very difficult to match colours and shades. Moreover the percentage used in mixing batches of dyes varies so much, the strength of the dye-stuffs being uncertain, that it is difficult to get the same colour twice in succession.

As regards designs, in cases of carpets and rugs made to order, the manufacturers can supply them or they can be furnished by the buyer from abroad. New designs are desirable, and it is a good plan for the buyer to furnish his own designs.

GROWTH OF CO-OPERATIVE DAIRYING IN NEW ZEALAND.

Perhaps no other country has witnessed so rapid and so great a development in the output of dairy products as New Zealand, or has seen such a wonderful advance in the scientific and mechanical details of manufacture. New Zealand has probably the largest and best equipped butter and cheese factories in the world, and its dairy farmers use separators and milking machines to a greater extent than elsewhere.

It is not only in mechanical and scientific development and the magnitude of its dairying output that New Zealanders have shown their energy and ability; in co-operative and financial organisation also they have achieved great results. The old privately-owned butter and cheese factories have almost universally given way to the co-operative business, in which the milk suppliers are the chief and, in most cases, the only shareholders. These associations are conducted, of course, entirely in the interests of dairy farmers. Some of the companies purchase fertilisers, implements, machinery, and other goods for their members, and even advance money for stock machinery, etc. They provide instructors who advise new farmers in the ways of handling dairy cows, growing fodder crops, and, of course, in the ways of increasing and improving milk production.

Of late years, writes the United States Vice-Consul at Auckland, there has been a tendency for individual factories to co-operate and even for co-operative associations to amalgamate. Striking instances of this development have taken place in the Auckland Province, where the dairying industry has expanded remarkably. The New Zealand Dairy Association was formed from a private company in 1901. Prior to its flotation as a co-operative company its output of butter was 1,200 tons per year. Under the new arrangement it soon became a very large concern, having 3,500 milk suppliers and manufacturing 6,000 tons of butter and 1,000 tons of cheese a year, whilst its annual sales amounted in value to nearly £1,460,000. Recently this association amalgamated with the Waikato Co-operative Dairy Co., which latter concern began in 1909-10 with an output of 150 tons of butter and a turnover of £14,600; in 1913-14 its output was 1,100 tons of butter and the turnover about £120,000; in 1918-19 its output was 1,000 tons of butter and 2,250 tons of cheese and the turnover £584,000.

The new amalgamation is known as the New Zealand Co-operative Dairy Co. (Ltd.), and is said to be the largest co-operative company of its kind in the world. The new company will have 5,000 suppliers, and will receive the product of about 100,000 cows. It has eight butter factories, ten cheese factories, and a large number of creameries. The output of butter this season is estimated at 8,500 tons, of cheese, 2,500 tons, dried milk, 2,000 tons, and casein, 300 tons, whilst the value of the turnover will approximate £2,400,000.

CORRESPONDENCE.

COLLOIDAL FUELS.

With reference to the recent discussion on the above subject in the *Journal* of August 13th and 27th, I should like to add a few remarks.

Colloidal fuel is a mixture of coal in a pulverised form and a petroleum residuum, such as is left after the extraction of the lighter and more valuable products.

The application of colloidal fuel is a development of the use of "straight" pulverised coal, for which it is already claimed that a more economical use of the total available heat energy in the coal is possible. Pulverised coal has been used commercially, and in the United States alone eight million tons of pulverised coal were manufactured in 1918.

Mixing oil and coal has the object of combining the advantages of both fuels, and with the mixture in a fluid state, the handling during transportation, distribution and storing on one hand, and the burning in the boiler, furnace, or stove on the other, present no technical difficulties.

Owing to the higher degree of combustion, the handling and labour charges, incidental to the removal of ash and clinker, are negligible. The stand-by losses are equally small owing to the ease with which steam can be raised, and its pressure controlled, in the case of a boiler, and any desirable temperature readily attained and maintained in the furnace.

Again, the higher heating value gives a more favourable fuel consumption, which reacts on the size of the storage tanks of the plant. The deterioration of coal, which is common with prolonged storage, is prevented; the danger of explosion when handling pulverised coal only is eliminated; the utilisation of huge quantities of "waste" coal, which so far only find limited application in the manufacture of briquet, is made possible.

On the other hand, however, there are difficulties which must not be lost sight of.

Coal must be crushed to a certain degree of fineness, and during that process the fuel passes through magnetic separators, drying plants (kept at a specific temperature), vertical or horizontal pulverisers (the degree of pulverisation depends on the number of operations and the method of mixing), and must be kept in specially designed stores until required for mixing.

The power required for crushing each ton of coal is about fifteen to twenty horse-power hours, and the cost varies according to output, the cost per ton in a 1,000-ton plant being only about one-fifth of that in a 5-ton plant.

Again, after pulverising the coal must be mixed with the oil, the cost being again proportional to the output.

As regards the actual mixer, it is obvious that the permissible percentage of coal will depend on the grade of the residuum. To-day, large quantities

of heavy fuels are available which, however, are very viscous. If the suggested ratio of 50 per cent. coal and 50 per cent. oil is applied in these cases, the practical difficulty of handling the mixture will arise.

From a commercial point of view, a mixture possesses an economic flexibility. As prices of the various constituents fluctuate, so their percentages are adjusted. As mentioned above, there are certain technical difficulties which will, therefore, govern the price of colloidal fuels.

Again, the cost of crushing and mixing affect the selling price, and the large consumer who can buy in the open market the requisite amounts of coal and oil at an economical figure, and then prepare this mixture in his own plant, is certainly at a very great advantage. The moderate and small consumer is in a less favourable position, and will have to pay such prices as are fixed by the colloidal fuel producer.

Colloidal fuel is quite suitable for power generating stations, industrial furnaces, railways, and, in fact, most stationary plants where the generation of heat is desirable.

Its suitability for marine oil-fired installations depends on a suitable grading of the mixture, if the modern practice of carrying the bunker in the double bottoms is to be adopted. Otherwise technical difficulties will arise, and the additional expenditure incurred in the alterations on board ship will make the scheme an unattractive proposition.

For internal-combustion engines, colloidal fuel as a commercial commodity is of no interest to-day.

J. L. CHALONER.

OBITUARY.

SIR LINDSAY WOOD, BT., M.INST.C.E.—The death occurred on the 22nd inst., at Chester-le-Street, of Sir Lindsay Wood, at the age of eighty-six.

Born at Killingworth Hall in 1834, he was educated at the Royal Kepier Grammar School, Houghton-le-Spring, and King's College, London. After serving his apprenticeship as a mining engineer at the Hetton Collieries, of which his father was then manager, he was appointed viewer at North Hetton Colliery, and subsequently became assistant manager to his father, on whose death in 1866, he was made managing director of the Hetton Collieries. He was also managing partner of the North Hetton Coal Company and managing director of the Harton Coal Company, and was on the board of John Bowes and Partners, the Netherton Coal Company, the Newcastle Electric Supply Company, the Durham Collieries Electric Supply Company, the Hendon Paper Works, and the North-Eastern Railway Company. He was mining engineer to the Ecclesiastical Commissioners and to the Greenwich Hospital. He rendered useful service on various Royal Commissions, among them that on Accidents in Mines, 1879–86, and that on Coal Supplies, 1903–5. He was president of the Northern Institute of Mining and Mechanical Engineers from 1875 to 1878. As president of the Durham Coalowners' Association, which post he occupied for over forty years, he won the confidence of the miners' leaders as well as of the coalowners. He was also chairman of the North of England United Coal Trade Association and of the Durham Colliery Owners' Mutual Protection Association. Before the passing of the Education Act of 1870 he had himself provided an efficient system of elementary schools in the neighbourhood of his own collieries, and his consideration for the well-being of those dependent on him showed itself in countless ways.

He was an active supporter of the Unionist cause, president of the party organisation in the Houghton-le-Spring Division, and chairman of the Durham County Division of the National Union of Conservative and Constitutional Associations. He was a Justice of the Peace and a Deputy-Lieutenant, and was sheriff in 1889. He was created a baronet in 1897.

He became a member of the Royal Society of Arts in 1882.

GENERAL NOTE.

THE WOLSELEY SHEFFIELD PLATE.—The late Dowager Viscountess Wolseley's collection of Sheffield plate, recently bequeathed to the Victoria and Albert Museum, is now exhibited in the East Hall. The collection occupies five large cases, and is remarkable both for the number of pieces and for their quality. It ranges over nearly the whole period of the art, from its earlier efforts, imitating the designs and even simulating the marks of solid silver in the rococo style of 1750-60, through the Adam classic manner of the latter half of the eighteenth century, to the heavier forms of the early years of the nineteenth century. The period of decadence, marked by the revival of an extravagant rococo, the last development of the industry before it was swept away by the invention of electro-plating about 1840, is alone practically unrepresented. As works of art the examples of the middle period, ranging in date from about 1770 to 1790, are the most pleasing. A few pieces of plating on brass are included in the collection as interesting examples of another method than the rolling together into one sheet of a layer of silver and a layer of copper, which constituted the old Sheffield process. By this important bequest the Museum is enabled to give an adequate representation of the growth and development of Sheffield plate, a truly national art invented by an English workman.

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FRIDAY, OCTOBER 1, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

INDIAN SECTION.

SPECIAL MEETING.

On FRIDAY, OCTOBER 15th, MR. THOMAS M. AINSCOUGH, O.B.E., His Majesty's Senior Trade Commissioner in India and Ceylon, will read a paper on "British Trade with India."

The chair will be taken at 4.30 p.m. by SIR CHARLES C. MCLEOD.

INCREASE OF SUBSCRIPTION.

At the Annual General Meeting, held on June 30th, it was unanimously resolved that the annual subscription of Fellows be increased from £2 2*s*. to £3 3*s*., and the Life Composition fee from £21 to £31 10*s*. The new scale will apply to all subscriptions due on and after Michaelmas, 1920.

These changes have been necessitated mainly by the great increase in the cost of the *Journal*, which rose from £1,767 4*s*. 11*d*. in 1913-14 (the last year before the war) to £2,851 11*s*. 10*d*. in 1919, and will probably rise further to about £3,800 for the current year. The general costs of maintenance and of conducting the work of the Society have also inevitably risen. Further particulars as to the financial position of the Society were published in the report of the Annual General Meeting in the *Journal* of July 2nd.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

RECENT RESEARCH IN CELLULOSE INDUSTRY.

By CHARLES FREDERICK CROSS, B.Sc., F.R.S.

Lecture II.—Delivered February 23rd, 1920.

CELLULOSE INDUSTRIES.

The cellulose industries fall naturally into three groups :—

(*a*) Manufactures which are based on the vegetable fibres, or more massive products of plant growths ; and which make use of and develop the external properties of these products.

(*b*) Manufactures based on the properties of these products as chemical individuals, more especially the chemical properties of their main constituent, cellulose.

(*c*) Industrial processes of resolution to ultimate products of value.

In the typical cases to be discussed in the present essay it is impossible to observe the sequence of this classification : the industries overlap, and it is a feature of their progress that they tend to overlap more and more.

From obvious causes the staple industries of group (*a*) are a growth rather than a creation : whereas in (*b*) and (*c*) a particular discovery, *e.g.*, of a reaction or a synthetical derivative of cellulose, may create or initiate an industry.

As a result of experience under the stress of war conditions there is a general recognition of the exceptional importance of the cellulose industries : they are not only key-industries, they are in the primary sense conditional of our existence as a civilised nation.

There is no need to insist upon what is now articulately recognised. Nor is it in the scope of these lectures to develop any theme, general or sectional, in detail.

The present purpose is an impressionist survey which will indicate lines of progress, technical and scientific, and the prefatory reference to the grouping of the cellulose industries is merely by way of suggesting a question of some importance : is there a sufficiently homogeneous science (including technology) of cellulose to justify the education and training of the cellulose expert; or is it to be presumed that a training in science is the full equipment, and that the technology of cellulose, incidental to and illustrative of general knowledge, may be left to the science-trained student to acquire incidentally ?

If this is to be taken into consideration as a formal problem, it may be of use to set out the range of industries involved :—

(*a*) Textile and paper-making, and auxiliary chemical industries.

Applications of straw and wood plait in hat industries ; timber and wood working.

(*b*) Nitro cellulose explosives, celluloid, film or sheet, and massive solids.

Cellulose acetate, varnishes (dopes), films, solids, and artificial textile fibres.

Mercerisation (lustre finish) of cotton textiles; parchmentising (cellulose papers).

Viscose manufactures, mainly "artificial silk" and threads (crin) and film (cellophane).

Cuprammonium solutions and applications to artificial silks and waterproofed textiles, papers and boards; zinc chloride solutions ; applications to manufactures of insulating materials.

(*c*) Wood distillation; oxalic acid manufacture ; cellulose fermentations.

In all these industries, the knowledge of the cellulose specialist is involved : problems are referred to him, and he is expected to have a general knowledge of the routine of practice and processes in the conduct of which most of these technical problems arise.

On this view, the supply of the raw materials is assumed; but their production involves the industries of agriculture and forestry. The cellulose specialist cannot ignore the essential perspective of his subject as a section of the natural history : and he has to deal with practical problems which arise in this connection, *i.e.*, the growth and preparation of these raw materials of industry.

This is an obviously formidable range of practical, wealth-producing activities ; and if experience is a necessary qualification for the career of the cellulose specialist, it appears to impose a very extensive training beyond the academic grasp of primary subjects.

For the guidance, and perhaps encouragement of any who may be attracted to this career, particular experience points rather to a training in science and the fundamental subjects of biology, chemistry, and physics, as the full primary equipment. Thereafter there should be some working experience in the textile and paper-making industries.

Technical work and experience is, for obvious reasons, of much less value as general education: it is obvious that the trained mind can easily assimilate technology, and with intelligence as well as intellect, the science-trained man is the best for the position of directive authority. The converse is generally, and quite wrongly, assumed in this country. And this is the cause of our having abdicated leadership of technical and industrial progress and development.

In the competitive era on which we have entered, we may either rely, as heretofore, on the spontaneous generation of the right men, with the right mind and morals to assure leadership, or at least the success of holding our own in cellulose matters : or we may adopt a deliberate constructive policy, and leave to chance only those elusive elements of personal equipment, which belong to imagination and take expression in enthusiasm.

Next to the provision of men, of workers, comes the important question of raw materials. It is a somewhat disturbing reflection that we depend in large part upon the outside world for our staple supplies. This absence of "control" has its consequences, and these no doubt are weighed and calculated by our politicians, in relation to the problems of international equilibrium.

On the broader view of men and nations, it is a feature of our natural history that the civilised life of mankind is dependent upon cellulose, and, in fact, largely dominated by cotton, whether taken as a massive product or considered as the minute entity, the ultimate individual cotton hair. It is also a feature of our most important staples, cotton and flax, that their economic production involves, in addition to the textile fibre, the simultaneous production of our two most important oil-seeds.

As a comment on the economic history of mankind, it is to be noted that up to the year 1860 the cotton seed was a waste product, even to the point that its destruction was the subject of compulsory legislation in the United States, to prevent insanitary accumulations in the cotton area.

The present production in the United States is some 6,000,000 tons per annum, requiring 850 mills as the equipment for converting to cotton oil and cake. It would appear that the cotton crop at least in the United States is fully utilised. The industrial position of the flax crops of the world is similar to that of the cotton crops of fifty years ago, but conversely as to the incidence of the waste : it is the flax straw, with its potential 15–20 per cent. fibre, which is destroyed, the portion of the flax crop which furnishes the textile flax of the world is only a fraction.

The above, however, is only a superficial and

general survey; for the cotton crop is still subject to prominent waste of harvested material, in the form of the short fibre remaining attached to the seed after the removal of the long staple textile cotton. This waste, however, has been taken in hand by a number of industrial technologists, and through their labours it is being brought within visible distance of full utilisation. Cotton hull fibre, as an industrial realisation, furnishing a new staple raw material for paper-making, and for the industries based on the synthetical derivatives of cellulose, is a peculiarly interesting chapter of industrial evolution.

It has been fully dealt with in recent technical literature (E. de Segundo, *R.S.A. Journal* and J. Soc. Chem. Ind., 1918), and therefore requires only this mention, with the fact that the bleached "hull" fibre is now on offer to the paper trade on such terms as lead to the conclusion that this colossal waste will be in due time integrally converted to use. The potential supply was estimated by Beadle and Stevens (J. Soc. Chem. Ind., 1909) at 120,000 tons per annum.

This marks a definite stage in progressive industrial economy, but to achieve the quantitative realisation of commercial values potential in harvested cotton, does not imply any advance in science: it was possible in 1860. There are, however, other values, and to explore these the researches required are of the purely scientific order.

In this perspective, the values which dominate industry are of the ultimate order, the qualities and properties (1) of the individual cotton fibres, (2) of the cotton substance as an assemblage of products, *i.e.*, of cotton, cellulose and non-cellulose.

In (1) are comprised (*a*) the factors of production of cotton, biological and agricultural; (*b*) the factors of the spinning processes.

This aspect of the subject has been dealt with by Dr. Lawrence Balls in a recent lecture, under the modest title, "Some Applications of Research to the Cotton Industry," *R.S.A. Journal.* It is unnecessary to traverse this weighty contribution to progressive science. With a sketch of the author's cultural researches, and reference to his more exhaustive publications, the student is furnished with full initiation into a fascinating study of natural history, and the attention of practical men is arrested by the opening dictum: "The whole technique of the cotton manufactures—our largest export industry—is based upon the properties of single unicellular seed hairs."

The link between the science of the biologist, and the exact knowledge of the scientific spinner, is through the expert valuer or grader of commercial cottons. Dr. Balls' analysis of the technique of evaluation, personal and impersonal, is of particular critical interest and value, and his investigations led to the invention of his grading machine—demonstrated and described—by which a sample of commercial cotton can be rapidly and accurately sorted and laid out in differentiated lengths (staple).

Now, to the practical mind it might appear that spinning quality is a direct and simple function of fibre length, and that the machine might take the place of the person (grader). But the inventor had no such expectation. It was clear to him that while the grader handles his sample with special manipulation to measure "staple," and apparently main attention to fibre length, there is a less conscious process of evaluation of other properties—qualities of substance and associated factors of integral "spinning quality."

There is a parallel case of expert evaluation in another cellulose industry which may be cited, perhaps by way of consolation to the "expert" in an age of mechanical inventions which menace his position.

The papermaker, the paper buyer, always engaged in a rapid comparative valuation of papers, has a particular basis of estimate, demonstrated by the comprehensive term "handle." Certain of the factors of the handle are accurately measureable, and so far, therefore, a comparative valuation is possible to a person, without the special qualifications of the expert. Another instance is the judgment of value in the case of textile goods, in which questions of "finish" are sometimes deciding factors.

These all illustrate an important general characteristic of the cellulose industries—a highly specialised, and in many respects, scientific development, but based on empiricism and experience, and therefore still awaiting the development calculated to follow from the application of scientific method as formally defined and understood.

In the case specially under consideration, the biologist enters the field; in logically developing the basis of investigation, and requiring accurate analyses of cottons in terms of fibre length, he invents a mechanical grader. This invention, however, is only incidental to a laboratory

investigation of spinning quality, Dr. Balls having passed by logical transition to the field of cotton spinning, as Director of the Research Laboratory of our Fine Spinners' and Doublers' Association (Manchester).

It is not for us to anticipate the publication of his research work in this field. It is evident that an industry which produces a cotton yarn of length-weight, *e.g.*, 200 miles to the 1 lb., must have arrived at a highly organised technique. It is generally known that this advanced technique is not based upon the order of control represented by measurements of dimensions and qualities of the ultimate cotton hair, but it is *a priori* clear that such is the present objective of the directors of the Association, and of Dr. Balls' research work.

In these terms the factors of spinning quality are :—

(*a*) Length and diameter of fibre, and other details of structural form, including the number of convolutions per (multiple) unit of fibre length.

(*b*) The composition of the fibre substance as a complex of chemical products, cellulose, and a group of "non-cellulose" components, cuto-cellulose, wax, pectic carbo-hydrates, and colloidal proteids ; last, but by no means least in importance, the variable water component, "hygroscopic moisture," of the complex, variable directly with the variations of humidity of the atmosphere.

The obvious practical measure of spinning quality is the highest technical-commercial value realisable from a given grade of cotton ; and the more obvious factors of value are the fineness, *i.e.*, maximum length-weight, strength (including elasticity), and uniformity of the yarn. Commercial values of yarns are certainly standardised up to a point in terms of these values, but the limitations of their applications are recognised.

As an illustration, it appears a simple mechanical operation to measure the strength (breaking strain) and "elasticity" (extension under breaking strain) of the yarn. But from the scientific or actual point of view the rupture of a yarn is a very complex physical effect. It is a simple operation to "blow out" a lighted candle ; but the extinction of the flame involves several physical-chemical factors.

It is sufficient for the present purpose to indicate in this superficial critical forecast, what is involved in the organised tasks of applying exact science to a highly-developed technical industry, necessarily embodying the accumulated results of experience, and exact practice, that is of highly scientific empiricism.

As a critical illustration of the extension of the field of vision, and the judgment essentially characteristic of this new development, we must mention Dr. Balls' demonstration of the daily growth rings in the cell wall of cotton hairs (Proc. R.S., B. 90 (1919), 542–559).

Applying a reaction which developes a regulated re-hydration of the cotton substance, a limited viscose reaction (Cross and Bevan Pat. 126174—1918), it was found possible to "swell" the fibre without structural distortion, and multiplying the 40·50 fold increase of dimensions by optical analysis with a $\frac{1}{12}$th in. lens, the actual magnification reached 20,000.

For the exact histological technique of the research, however, the optimum range was found to be at 5,000–9,000 diameters. The scope of this research will be appreciated by students of exact science, in the terms of an important conclusion in the published paper:—the dimensions of the wall of the lint hair are such that the thickness of each of the twenty-five growth rings can only be, at most, 0·4 μ, much less than the wave length of sodium light. Also it will illustrate the linking up of chemistry and biology with the technics of a great manufacturing industry. Workers of this school require no further proof of progress ; the "practical" school, moreover, has reached the position of the open mind, and not only in the cotton industry, but in the other leading textile groups, based on their respective raw materials, flax (and hemp), and jute. These have now their research associations, and the problems to be attacked range from the cultural to those of the spinning and auxiliary industries, and, lastly, to the countless problems of the everyday use of the fabrics. Of these the cellulose specialist has practical experience as detached questions of difficulty, and often of damage.

But the re-investigation of the industries, to bring them under the control of exact science, is in each such case a comprehensive parallel with what has been sketched above in the case of cotton, which is the typical form of "cellulose," both as textile fibre and chemical individual, and is the main text of this brief survey.

In actual new developments, of developments of the newer textile industries, we may briefly notice two, and mainly by way of exhibition of fabrics which show the wide range of effects, beautiful and useful, which they cover.

At the one extreme is the artificial silk, and at the other the twisted paper yarn.

The war conditions of the period 1914–19 have specially affected these industries, arresting the expansion of the cellulose "silk," but greatly stimulating the growth of the latter. The world production of artificial silk is estimated at about fifty tons per day, and mainly by the "viscose" process. A new form of the product is the "staple fibre" of the (German) Vereinigte Glanzstoff A.G., and "fibro" of British manufacture, which is manipulated as a fibre of short length (4–5 cm.) and spun into yarns of a type intermediate between "spun silk" and wool. We may refer the reader for the latest technical information to a recent article in the Journal Soc. Chem. Ind., by L. P. Wilson, 39 (1920), B. 266.

The industry in (twisted) *paper yarns*, which had struggled to hold a competitive position under normal industrial conditions, was developed in Germany and Austria during the war to the astonishing production of 250,000 tons per annum, being applied as a substitute for the staple long-fibre textiles in the most varied directions.

The industry in this country is represented by the Textilite Engineering Company, 36–38, Queen Street, E.C. 4, who have considerably advanced the technique of production. This firm kindly supplied an extensive exhibit of great technical interest, and to them we may refer our readers for information in detail.

In conclusion of this textile section, we notice the "artificial silk" of the British Cellulose and Chemical Manufacturing Company, of London and Spondon.

This product is the acetic ester of cellulose, drawn from solution to a lustrous thread in continuous length; the textile yarn being a multiple thread with sufficient twist for working on the loom or otherwise.

The manufacturing company kindly supplied an exhibit of the product which has an obvious scientific and technical interest. On the technical-industrial aspects of its competition with the cellulose silks, we refer the reader to the paper of L. P. Wilson (*loc. cit.*), and a later note by J. F. Briggs (*ibid.* B. 286).

It should be mentioned that the acetate silk has been manufactured for some time in the United States by the Lustrose Company, of Boston, developing the work of the distinguished group of cellulose specialists, A. D. Little, and his associates, Messrs. Miles and Mork. The Miles patent, 838,350, 1906, U.S.A., marked an important stage of technical progress. A clear exposé of the technical history of the acetate processes is given by E. C. Worden in Journal Soc. Chem. Ind., 38 (1919), 370.

There is a factor of value in cotton fabrics which requires mention, not only from its obvious importance, but because it is frequently left out of consideration; and, again, because it is a link between a number of cellulose industries in regard to technical progress. Cotton yarns are not measured in terms of specific volume, *i.e.*, apparent volume. In paper values, on the other hand, the specific volume or specific weight comes into practical consideration; but for a discussion of the technical bearings of this section of the subject, readers are referred to "Paper Making," Cross & Bevan Ed., 5, pp. 401–403.

In the case of artificial silk the question of "bulk" of the yarns arose, perhaps accidentally to become, at maximum bulk, a definite objective of the process. This apparent bulk evidently measures the covering power of the yarns in weaving. This quality finds a very striking illustration in the industrial application of another vegetable fibre, kapok, as the basis of appliances for life-saving in the sea services. These appliances came into prominence during the war, and investigations were required by the Boddy Company of the qualities of different grades of this fibre. Some results of these investigations are recorded in a paper in J. Soc. Dyers, col. 32 (1916).

The following results of further investigation may be mentioned.

In respect of volume occupied by a mass of the fibre under compression, it was found that, compressed by hand in a regular cylinder by means of a plunger, 1 gram of the fibre occupied volumes of 10·0–13·2 cc.: this is the measure of its quite exceptional floating power, and the efficiency of the appliances in question, as compared with appliances based on cork, with its volume (in mass) of 4·0–5·0 cc.

In investigating the relation of the fibre in the mass, and the individual seed hair to increased pressure, the following results were obtained—a comparison being made with cotton:—

	Vol. of 1 grm. compressed by hand.	Pressure to reduce vol. to one half.	Break down pressure.
Kapok .	10·0 cc.	3·8 atm.	100–120 atm.
Cotton .	3·6 ,,	7·5 ,,	720–840 ,,

In reporting these results, Mr. R. H. H. Stanger, who carried out the tests, called attention to the localisation of the breakdown —disintegration of the fibre—at the centre of

the compressed mass, and to the fact that in further investigations the air-factor would require special investigation.

The subject is mentioned here in reference to the practical question of compression of the fibre (kapok) to bales for transport.

The fibre-substance is recognised as being sensitive to frictional wear, losing volume in the mass, and having its special quality of resistance to wetting. This subject is only superficially touched by the above investigations, but opens out some fundamental technical points which have received but little attention.

The industries based on the properties of cellulose, as a chemical individual, are vast and diverse. The transformation of cellulose to artificial fibre has been noticed in regard to technical progress.

A brief mention is required of an industry which, for obvious reasons, grew rapidly to colossal proportions during the war. Cellulose nitrate, as the basis of modern "smokeless" explosives, was a *sine qua non* of the great war. On the technical aspects of "nitro-cellulose" manufacture, there are two secondary factors of quality which require mention: (1) The stability of the product; (2) the viscosity of its solutions in specific solvents.

In regard to (1) the recognition of sulphuric residues in combination as cellulose sulphuric esters (Cross, Bevan and Jenks, Berl. Ber. 34 (1901) 2496; Hake, J. Soc. Chem. Ind., 24, 374) has led to more definite control of the "stabilisation" treatments. But there are other causes of instability, additional to the primary property of a highly explosive compound. In this more complex question is involved that of raw material, *i.e.*, the basis of cellulose. This was a subject of investigation and correspondence in 1910–11, as between the writer and Mr. W. Rintoul of the Nobel's Explosives Co., on the special point of a "normal cellulose" and its definition. On general grounds a calico printer's "madder bleached" cloth appears to conform with such specification. Mr. Rintoul investigated a series of specimens, prepared by slightly varied treatments, and his figures for the systematic control tests confirmed this selection of the typical "normal" cotton cellulose:—

Solubility in 3 per cent. NaOH	1·66	per cent.
Copper reduction	0·39	,,
Ash	0·16	,,
Dyeing test . . .	Uniform, light, medium.	

Mr. Rintoul compared these figures with those of his records of tests of "hundreds of specimens of cellulose from various sources." Of such the one exceptional best gave:—

Solubility in 3 per cent. NaOH	2·36	per cent.
Copper reduction	0·42	,,
Ash	0·69	,,
Ether (soluble)	0·64	,,

Mr. Rintoul's industrial experience would, no doubt, be mainly with "waste cottons" of all kinds; the scientific investigations of the Nobel Co., on the other hand, necessarily traversed the wider field of first principles. Thus the writer has been associated with him in an investigation to determine the thermal constants of the primary ester reaction:—

$$C_{12}H_{20}O_{10} + 5\ HNO_3 = C_{12}H_{15}O_5(NO_3)_5 + 5\ H_2O.$$

The elaborate physical research work involved has been undertaken by Mr. Bousfield, F.R.S., and the results, which will be published in due course, necessarily involve close verification. This research is noted here as evidence of progress, but also of our lack of knowledge of fundamental things in the general chemistry of cellulose.

The question of "waste cottons"—as, up to a period, the exclusive raw material for this industry—has been elaborately re-investigated, under the exigency of war conditions, by Sir R. Robertson, F.R.S., and the technical chiefs of the Naval and Military Services. Their records must be a document of high scientific and technical interest, and we may hope in due time to be able to include it in the general history of the subject.

One section of the research, however, and perhaps the most important, is the subject of a paper by Dr. W. H. Gibson (Chem. Soc. J., May 1920, v. 117, p. 479). The author applies a *positive* criterion and control of "cellulose quality" in relation to the properties of the nitric esters, in terms of viscosity of solutions in a standardised cuprammonium. Beyond the contribution to technology, the paper opens out a number of directions of investigation of ultimate problems, and is therefore commended to students for close study. Specialists require no reminder of the suggestive character of the publication.

Dr. Gibson is chiefly concerned on the technical side with "cotton wastes." But the department has had to consider other problems in connection with supplies of raw materials. The data not being published, there is only "general knowledge" of the fact that, for special types of nitro-cellulose ammunition, it was found advantageous, and in fact necessary, to adopt

a prepared raw cotton, *i.e.*, in the advanced state of mechanical purification represented by a spinner's sliver. It is to be inferred from this, that the associated mechanical impurities of a raw cotton, are a definite cause of instability of the nitrate products; but perhaps also, an unmanufactured cotton permits direct control, in terms of invariable, or least variable viscosity, of the solubilised nitrates.

In concluding this section, there are two raw materials to be mentioned, as having become prominent during the war. The first of these is the short-fibre waste from American cotton seed, already mentioned on general grounds of industrial value.

This material was utilised on a very large scale in the United States for the production of "nitro-cellulose" explosives and ammunition.

The second is wood cellulose, to the use of which our enemy-friends were forced by the restriction of their cotton supplies. It was suggested, but only in our daily journals, which still reflect the public indifference to scientific-technical matters, that to cut off cotton supplies to the enemy countries would be to end the war, *ipso facto*. There is some support, it is true, for the general dictum, to be translated into the language of those more directly affected, "Ohne Baumwolle—kein Krieg"; and the experience of our own specialist departments, recorded above, is to be cited in illustration. But the facts are that wood-cellulose was used on the large scale in the production of nitro-cellulose powders.

Incidentally, this question of cotton cellulose in comparison with wood cellulose raises the deeper scientific problem of "normal cellulose," and directs attention to the natural paradox of a seed-hair of an annual plant representing the normal cellulose, *i.e.*, as prototype, whereas the wood cellulose of perennial forest trees occupies the inferior position in regard to chemical inertness or non-reactivity, which means stability.

It will be already evident to the reader how wide and apparently diversified is the range of subjects and interests connoted by the title of this lecture; that it has been necessary to treat the subject-matter discursively and suggestively rather than exhaustively; and that a still more condensed mention must suffice for the remaining matters—interesting by way of promise of technical progress.

The "limited viscose reaction" (Cross and Bevan, U.K. Patent 126,174, 1918) has been already noticed in connection with its major effect: the controlled hydration of the fibrous celluloses with increase of dimensions up to 20–60 diameters. The basis of the reaction (of hydration) is (1) treatment with caustic soda solution at 9–10 per cent. $NaOH$ in the cold, and squeezing so that the cellulose mass retains 2·33–2·66–3·0 times its weight of the lye; (2) afterwards exposing to carbon disulphide as in the well-known viscose reaction, but for longer periods.

Subsequent treatment with water removes the excess of $NaOH$, the fractional quantities of soluble xanthate (cellulose) and thio-carbonate by-products, but there is a disproportionate hydration effect, the degree of which is variable directly with the proportion of $NaOH$ (lye) to cellulose. The much swollen hydrated fibres form a gelatinous colloidal mass, but retain a certain quality of "free" working on a paper-maker's wire cloth, such that it can be worked up into sheets. According to the method of subsequent treatment for dehydrating the fibre, the cellulose "reverts" to its original state, the sheet or felted mass is soft and coherent only through the interlacing of the fibres; or the reversion is partial, with the result that the sheets have a parchment quality, coherent and semi-transparent.

This process opens out a general critical revision of the major preparation treatment of the paper-mill—the beating operation. In this operation several factors are involved, of which two are particularly brought under independent control (1) length of fibre, (2) degree of hydration of fibre substance. Not only in the paper-making process, but in finishing and dyeing treatments of cellulose textiles, a controlled hydration treatment opens out the investigation of new resultant effects. These investigations are in progress. There are, moreover, certain bearings of the results upon the ultimate problems of chemical constitution which remain to be discussed, and are deferred to the next lecture.

A certain parallelism with this completed range of effects of the xanthic reaction characterises the interaction of the cellulloses with solutions of the sulphocyanides. These reactions were observed and studied some years ago by A. Dubosc (Bull., Rouen, 1905), who claimed to obtain solutions of cellulose capable of competing in industrial application with the cuprammonium product and others.

The matter has been developed by our friend Mr. H. Williams, of the Manchester Oxide

Company, and the following note is kindly supplied by him :—

"The gap between 'viscose' and the solution of cellulose in concentrated aqueous zinc chloride, and other acid and salt solutions, has recently been bridged.

"The action of thiocyanide solutions on cellulose was first investigated by Dubosc (Bull. Soc. Ind. de Rouen, 1905, page 318), and more recently P. Weirnarn (D.R.P. 275,882, 1914) claims the solvent action of any neutral salt solution '—the term 'action' being used in its widest sense; but these results do not appear to have been industrially developed. The subject has, however, been independently revived (Manchester Oxide Company and H. Williams, E.P., 123,784 and 124,979) on the basis of a systematic study of the metallic thiocyanide solutions, with the result that the action of any given salt of the sulphocyanate group is specifically to be predicted in terms of definite constants, *i.e.*, viscosity, heat of solution, etc.

"These systematic researches will be published in due course. On the industrial side, the work has led to processes for the spinning of thread and the production of parchmentising and 'vulcanising' effects on paper, of special advantage."

The document above referred to, the specification D.R.P. 275,882 (1914) of P. Weirnarn, is a noteworthy contribution to the subject. The scope of the research and of the resulting industrial processes may be judged from the claim of the patent which we give below (translated) :—

"Process for the conversion of cellulose materials of all kinds into different kinds of plastic or gelatinous masses, or colloidal solutions, distinguished by the fact that the cellulose is acted upon by aqueous solutions of neutral salts (solutions of zinc salts, potassium and ammonium thiocyanates, potassium iodide and potassium or barium mercuric iodides excepted) under conditions of concentration, pressure, temperature, and time of action depending on the nature of the salt."

Cellulose Fermentation.—The literature of cellulose fermentations is extensive; the natural processes are incidental to agricultural observation and practice, and have been specifically studied in special cases, as, for instance, in connection with silage (O. Emmerling, Berl. Ber. 30, 1869, 1897).

More specific researches are those of MacFadyen and Miss Chick of the Lister Institute, who studied special groups of thermophilic bacteria, in relation to the breakdown of typical forms of cellulose which we prepared for investigation.

The later researches of Omelianski (Compt. Rend., 1897) were more specific as to the ultimate products.

All these laboratory processes of fermentation have, so far, involved lengthened periods for complete breakdown of the cellulose, and would be excluded on this account from consideration as industrial processes.

But recent advances in research in this direction have evolved a controlled industrial process for the fermentation of celluloses, both fibrous and cellular, giving rise to ultimate liquid products in good yield. The following note of its results and scope is kindly supplied by Mr. Langwell and the Power Gas Corporation, Ltd., who are developing the laboratory results on the scale of an industrial unit. The process may be so controlled as to yield at will, either acetic acid or alcohol as main product.

Such a resolution of cellulose will doubtless have a very profound influence on the supply of liquid fuels in the future, as the most diverse vegetable products, at present of only nominal value, will yield to fermentation, and produce alcohol or alternative products at such cost, and in such quantity, as to compete to advantage with existing fuels from mineral oils and coal.

The prospect of producing fuel alcohol by the present brewing and distilling practice is excluded by the fact that the raw materials required are staple foodstuffs, as well as the "natural" sources of starches and fermentable sugar, with a consequent prospective high-selling value.

The production of alcohol from calcium carbide is also prejudiced by the high cost of raw material.

The simplicity of procedure in these new cellulose fermentations makes them workable in the most diverse climates, and the troublesome sterilisation is not necessary, as it is in ordinary distilling practice.

It seems probable, therefore, that they will become a source of liquid fuels in the future, meeting the present need, and utilising material available in enormous quantities, without competing with any other industry. For example, the Nile Sudd deposit alone, which is 35,000 square miles in extent, and only *one* of the massive cellulose wastes, would if fermented produce 50 to 80,000 million gallons of alcohol, or alternative products, per annum, an amount more than sufficient to supply the whole world

with liquid fuel, and still leave some over for domestic lighting and heating purposes.

Considering the other massive cellulose wastes and their wide distribution, such a superabundance will eliminate the possibility of a rise in the cost of raw material.

FISHERY INVESTIGATION.*

The opening up of our north-western fishing grounds and banks is due to the scientific curiosity of Wyville Thomson and his *confrères* as to the existence or non-existence of animal life in the deep sea. It was sheer desire for knowledge that attracted a host of inquirers to investigate the life history of river eels. The wonder of a fish living in our shallowest pools and travelling two or three thousand miles to breed, very likely on the bottom in 2,000 fathoms, and subjected to pressures varying from 14 lbs. to 2 tons per square inch, is peculiarly attractive. It shows its results in regular eel farming, the catching and transplantation of the baby eels out of the Severn into suitable waters, which cannot, by the efforts of Nature alone, be sure of their regular supply. Purely scientific observations on the life histories of flat fish—these were largely stimulated by the scientific curiosity induced by the views of Lamarck and Darwin as to the causes underlying their anatomical development—and on the feeding value and nature of Thisted Bredning and the Dogger Bank, led to the successful experiments on transplantation of young plaice to these grounds and the extraordinary growth results obtained, particularly on the latter. Who can doubt that this "movement of herds" is one of the first results to be applied in the farming of the North Sea as soon as the conservation of our fish supply becomes a question of necessity?

The abundance of mackerel is connected with the movements of Atlantic water into the British Channel and the North Sea, movements depending on complex astronomical, chemical, and physical conditions. They are further related to the food of the mackerel, smaller animal life which dwells only in these Atlantic waters. These depend, as indeed do all animals, on that living matter which possesses chlorophyll for its nutrition and which we call plant. In this case the plants are spores of algae, diatoms, etc., and their abundance as food again depends on the amount of the light of the sun—the ultimate source, it might seem, of all life.

A method of ascertaining the age of fishes was sought purely to correlate age with growth in comparison with the growth of air-living vertebrates. This method was found in the rings of growth in the scales, and now the ascertaining of age-groups in herring shoals enables the Norwegian fishermen to know with certainty what possibilities and probabilities are before them in the forthcoming season. From the work on the blending together of Atlantic with Baltic and North Sea water off the Baltic Bight and the subsequent movements of this Bank water, as it is termed, into the Swedish fiords can be understood, year by year, the Swedish herring fishery. It is interesting that these fisheries have been further correlated with cycles of sun spots, and also with longer cycles of lunar changes.

The mass of seemingly unproductive scientific inquiries undertaken by the United States Bureau of Fisheries, thirty to fifty years ago, was the forerunner of their immense fish-hatching operations, whereby billions of fish eggs are stripped year by year, and the fresh waters of that country made into an important source for the supply of food. The study of the growth stages of lobsters and crabs has resulted in sane regulations to protect the egg-carrying females, and in some keeping up of the supply in spite of the enormously increased demand. Lastly, the study of free-swimming larval stages in mollusca, stimulated immensely by their similarity to larval stages in worms and starfishes, has given rise to the establishment of a successful pearl-shell farm at Dongonab, in the Red Sea, and of numerous fresh-water mussel fisheries in the southern rivers of the United States, to supply small shirt buttons.

Fishery investigation was not originally directed to a more ambitious end than giving a reasonable answer to a question of the wisdom or unwisdom of compulsorily restricting commercial fishing, but it was soon found that this answer could not be obtained without the aid of pure zoology. The spread of trawling—and particularly the introduction of steam trawling during the last century—gave rise to grave fears that the stock of fish in home waters might be very seriously depleted by the use of new methods. We first required to know the life histories of the various trawled fish, and Sars and others told us that the eggs of the vast majority of the European marine food species were pelagic; in other words, that they floated, and thus could not be destroyed, as had been alleged. Trawl fishing might have to be regulated all the same, for there might be an insufficient number of parents to keep up the stock. It was clearly necessary to know the habits, movements, and distribution of the fishes, for all were not, throughout their life, or at all seasons, found on the grounds it was practicable to fish. A North Sea plaice of 12 ins. in length, a quite moderate size, is usually five years old. The fact that of the female plaice captured in the White Sea, a virgin ground, the vast majority are mature, while less than half the plaice put upon our markets from certain parts of the southern North Sea in the years immediately before the war had ever spawned, is not only of great interest, but gives rise to grave fears as to the possibility of unrestricted fishing dangerously depleting the stock itself. There is, however, another group of ideas surrounding the question of

* Extracted from the Presidential Address of Professor J. Stanley Gardiner, M.A., F.R.S., to the Geological Section of the British Association, Cardiff.

getting the maximum amount of plaice-meat from the sea; it may be that the best size for catching is in reality below the smallest spawning size. I here merely emphasise that in the plaice we have an instance of an important food fish, whose capture it will probably be necessary to regulate, and that in determining how best the stock may be conserved, what sizes should receive partial protection, on what grounds fish congregate and why, and in all the many cognate questions which arise, answers to either can only be given by the aid of zoological science.

JAPANESE POTTERY INDUSTRY.

(*Continued from page* 718.)

The great bulk of chinaware produced in Japan is made by the old methods of manufacture and to a very considerable degree is a household or community industry. For example, in the Seto district one family will be found making the models and moulds. On the village streets one can see these moulds being carried by hand on boards to another household where they will be used for the forming of the ware. Cups and saucers are produced in large quantities in this district, one man being able to produce by casting 2,000 cups per day; but the quality is very poor. When the ware is ready for burning it is taken to the kiln. All tableware undergoes two fires, the first being a low degree of heat known as the "biscuit fire," which thoroughly dries and hardens the ware so that it can be handled with safety, and which also enables underglaze decorations to be applied. The ware that has gone through the "biscuit fire" is dipped in a glaze which is practically a liquid glass composed of feldspar, lead, clay, flint, and, in some cases, a frit composed of borax and flint.

The old type of Japanese kiln is unique. The kilns are built on the side of a hill in separate units, according to the requirements of the individual or the community. In some cases there is but one kiln, and it is built at the bottom of the hill. As the factory enlarges, another unit is added to the side of the first kiln and at a higher level, according to the incline of the hill. As the kilns increase in number they also become of larger dimensions. The kiln resembles in shape the inside of the ordinary muffle or decorating kiln in the United States. The floor is usually covered with sand, and the firing is not begun until all the kilns have been filled with ware. The fire is started in the kiln at the bottom of the hill, the heat entering from fire boxes which extend the entire width of the kiln near the boundary between the two arches. Each kiln has a draft hole half-way up the side, above the hole where the fire is fed. The direct brunt of the heat is taken by a fire-brick wall. The flame and heat, circulating about the rounded roof of the kiln, pass into the kiln next above through a series of openings on the level of the floor of that kiln. The heat passes from one kiln to the other, the surplus from one drying out and warming the contents in the following kiln. Wood is used entirely in firing the kilns and is delivered to the kiln burner in bundles, each stick being about the size of a man's wrist and about 15 inches in length. The kilns are fed from either side through a small hole less than one foot in diameter, the tender putting in a stick at a time, a continuous process. The steady demand for wood has stripped the adjacent countryside of forest and the cost of fuel is very high. Four bundles of wood, altogether about three cubic feet, cost 1 yen (2*s.* 0½*d.*), four times the pre-war price. The firing of each furnace costs about 500 yen (£50).

The heat is intense. As each kiln acquires the desired heat the feeding is discontinued, and the firemen proceed to the next kiln above, which has already acquired sufficient heat to ignite the wood. By the time the third kiln is fired the first one has cooled sufficiently to permit the ware to be taken from it. These kilns are a crude form of the German Hoffman kiln.

As the ware is taken from the kilns it is ready for the market or for the decorating shop, as the owner may elect. Wares produced by community kilns are usually marketed through merchants in the central village. In such a community potters of all degrees are to be found, from the individual making special articles and having them burned by the owner of the community kiln to the manufacturer who has his own shops and his own kiln or kilns.

The aggregate production of the numerous pottery villages in Japan amounts to a considerable figure, and much of it finds its way into the channels of foreign trade. Nevertheless, with the cost of living increasing in Japan by leaps and bounds and with labour expenses rising in proportion, the day is not far distant when the highly organised and efficiently conducted modern pottery, with its labour-saving machinery and quantity production, will supersede the cottage and community system. The Japanese have not been slow in appreciating this tendency. In Nagoya, the centre of the industry in Japan, a pottery has been built on the most modern lines. Upon entering a new factory one is at first struck with the fact that labour is still by no means considered the first and greatest factor in costs. Every ton of material is brought to the works by man power. There is no railway siding. All the materials, bulky as they are in the pottery industry, such as clay, feldspar, flint, wood and coal, are carted in small one-horse wagons, each horse being led by a man. Such materials as come in bulk are piled on the wagon in shallow tray-like baskets, each containing an amount convenient for a man to carry. The second thing particularly noticeable is the large amount of hand labour employed in the breaking up and sorting of the raw materials, and also the exceedingly minute care taken in removing any foreign matter from the broken mass.

Saggars, as explained above, are the fire-clay cases into which the ware is placed for burning. Setters are fire-clay discs, or very low saggars

capable of holding but one plate or dish. In the Nagoya factory the saggars and setters are made in saggar machines varying in size according to the article required. These machines consist of steel dies which squeeze the clay into the desired shape, the pressure being applied by a screw press.

The same method used in other countries for the making or forming of the wares is in vogue in this factory, namely, pressing, casting, hollow-ware jigging, flatware jigging, throwing, and turning. The casting process is more largely used than that of pressing.

The ware, when ready for the first fire, is taken to the second floor and placed in the upper chamber of the kiln. It is then piled on tiers of bats supported by heavy clay props, as is usually done in the decorating kilns in America. The central part of the kiln is used for burning the saggars in their clay state, and they are piled up from the floor to the roof of the kilns.

The ware, as it comes from the first fire, is sufficiently burned to be entirely safe in handling, but can be easily broken between the thumb and finger. It is glazed in the ordinary way by dipping it in tubs of thin liquid glaze. The ware dries rapidly and is ready for the second fire after the bottoms and edges of the cups have been cleaned of glaze to prevent sticking.

The French methods of placing the ware are used. The plates, dishes, and flatware are placed in separate setters. All cups and bowls are put on rings, which are placed on the bottom of the saggar, and are not boxed as is customary in France. The plate setters are so evenly made that it is not necessary to fill in the edges with clay when fired. The fire of the glost kiln attains a heat equivalent to a No. 17 cone. These cones are made and supplied to the manufacturers by the Tokyo Kogyo Shikhenjo (Tokyo Industrial Laboratory). The drawing of the ware from the kiln is done with great care and rapidity, the unusual rapidity being induced by the fact that the man in charge is given a bonus for every hour saved.

The warehouse work in connection with the plant under consideration differs in many respects from the work of a similar kind in other parts of the world. Every piece of ware is carefully inspected and sorted and placed in four groups according to quality, namely, firsts, seconds, thirds, and job lots. About 10 to 15 per cent. are firsts, 25 per cent. seconds, and 35 to 40 per cent. thirds. Only firsts are exported. About fifty or sixty persons, mostly girls, are employed in the polishing-room. In addition to the perpendicular power-driven whirler for polishing the rims of such pieces as sugar bowls, teapots, etc., and lathes or horizontal wheels for buffing the edges of cups, small wheels mounted on flexible shafts, such as are used by dentists, are employed for the polishing of imperfections otherwise difficult to reach.

The decorating processes are similar to those in use in other countries, including decalcomania transfer work, printing and filling in, hand painting, ground laying, hairbrush tinting, gold-paste work, gilding, and etching. The dinner ware is decorated largely by mechanical processes, but very large quantities of decorative ornamental wares are hand painted.

After the ware has been sorted and examined it is taken to the packing establishment. It is first wrapped in paper, then taken to another room and packed with excelsior wrapping in cardboard boxes, each box being tied and labelled. It is then packed in large wooden cases and marked for shipment. These wooden packing cases, as well as the cardboard boxes, are made in the establishment.

One of the newer developments in the pottery industry is the manufacture of electrical accessories in connection with the rapidly expanding electrical industry in Japan. The large high-tension insulators demanded by hydro-electric development are made both in large factories, such as the great Morimura plant at Nagoya, and also by small individual workshops (on sub-contracts) in villages.

The large pole insulators are thrown on an ordinary wheel which usually is motor driven. When shaped they are passed to a second man who turns them to size with a tool. Finally they are carefully finished by hand before drying. They are glazed in the clay and fired once. One man carrying through all the processes will throw, turn, and finish four hundred insulators in a day, for which he gets about 1·70 yen (including a rice stipend).

Smaller white porcelain goods, insulators, cleats, rosettes, etc., are for the most part manufactured in Japan in the households alongside of dolls and teapots. They are moulded in plaster of Paris moulds, with a lavish expenditure of time and energy, from clay purchased ready for working, and are then fired in community kilns. With practically no overhead charges, such small manufacturers are able to compete successfully with modern factories. In fact, one large establishment which put in an insulator factory has been undercut in price by the small independent potters to such an extent that it has almost ceased to do business.

Dolls are made in nearly all the pottery centres of Japan along with other porcelain wares of every description. Few, if any, factories of any size devote themselves to the exclusive production of such goods. The world demand for toys during the war, due to the lack of German goods, has stimulated the production of Japanese toys. A large number of "Kewpie" dolls, in particular, are now made in Japan. One establishment in Seto devotes itself almost wholly to the manufacture of kewpies, with a production of one thousand a day. The factory cost of a 6-inch doll of this sort is approximately 5 sen (1¼*d.*) for the body and 5 sen for the decorating; total, 10 sen, or 2½*d.*

OIL-BEARING SEEDS AND NUTS IN GUATEMALA.

There is practically no vegetable-oil industry in Guatemala, excepting the production of a small

amount of castor and citronella oils. The oil-bearing seeds and nuts growing in that country, from which oil may be extracted, are the castor bean, citronella, cohune (corozo), coconut, sesame, and avocado.

Castor oil is produced in different sections of the country, principally in Antigua, Guatemala, and Escuintla. The output from the plant in Antigua has been estimated at about 3,000 gallons per year. The total exports from Guatemala in 1918 and 1919 were as follows:—1918, 23,378 lb., valued at 6,779 United States dollars; 1919, 27,400 lb., valued at 7,946 dollars.

The products of the royal palm tree are variously known as the corozo and cohune (coquito or coquillo). These nuts are all supposed to belong to the same general family, but have variations in size, shape, and oil-producing properties.

The corozo nut is found only in Guatemala and the southern part of Mexico. According to a report by the United States Vice-Consul at Guatemala City, it is estimated, after a recent survey made by Americans, that 100,000 tons of kernels may be produced annually. Twelve tons of nuts will furnish 1 ton of kernels, and these kernels yield about 52 per cent. of oil. The corozo nut grows only on the Pacific slope.

The cohune (coquito or coquillo) nut grows only on the Atlantic slope, and it is estimated that 60,000 tons of kernels may be collected annually. Ten tons of nuts will yield 1 ton of kernels, and the kernels will yield 67 per cent. of oil. An analysis of the oil produced from these nuts showed as follows: Water 3·28 per cent.; oil (as received), 67·20 per cent., equivalent to oil (moisture-free basis), 69·48 per cent. This is strictly a laboratory percentage of oil. Commercially, by the same process as copra oil is extracted, the corozo and cohune or coquito palm nut kernel yield 65 per cent. of oil, this oil containing a certain percentage of glycerine. Soap manufacturers claim that this particular vegetable oil produces a better lather soap than other oils.

What is called coquillo is exactly the same as the cohune, only the outside shell is thorny and pear-shaped. The royal palm nut tree grows wild and bears after 20 years, and up to 75 years. It bears nuts the whole year, with the principal maturing season from November to May. Eight months are required for the nut to mature.

There are several difficulties to be encountered in collecting these nuts in Guatemala. They are widely scattered, and it is difficult to transport them to the machinery for cracking and extracting the oil. They must be transported through swampy ground and almost impenetrable jungles on mule back or on the backs of mozos (porters). No satisfactory machine has, as yet, been designed to crack the nuts, and get out the kernel commercially.

The avocado grows in great profusion in Guatemala, and it is at present a subject of study by Mr. Wilson Popenoe, agricultural explorer for the United States Department of Agriculture. His bulletin entitled "The Avocado in Guatemala," published by the United States Department of Agriculture (Bulletin No. 743), gives a complete description of this fruit. It has been stated that the avocado oil is suitable not only for soap making and similar uses, but also makes a delicious salad oil. There should be a field in Guatemala for the extraction of this oil commercially.

OBITUARY.

ALFRED SIMSON.—Mr. Alfred Simson, a well-known East India merchant, died suddenly at Folkestone on September 6th in his seventy-third year. Senior partner of Messrs. Kilburn, Brown & Co., of London, and of Messrs. Kilburn & Co., of Calcutta, he was also Chairman of the Indian General Navigation and Railway Company, Chairman of the Caamaño Tenguel Estate, Limited, a director of the National Bank of India and of the Colonial and Foreign Banks Guarantee Corporation, and formerly Consul-General for Denmark in Calcutta. While a resident in Calcutta he rendered valuable services to the Indian Museum, and for some time was honorary secretary of the Zoological Gardens in that city. A great collector of rock crystals and chalices, some of his Indian specimens were lent to the Victoria and Albert Museum. A number of exquisite examples of artistic work in quartz from his collection were also exhibited at the Royal Society of Arts nine years ago to illustrate the course of Cantor Lectures on "Rock Crystal: its Structure and Uses," delivered by Dr. Alfred E. H. Tutton, F.R.S. Mr. Simson joined the Society in 18[illegible], and was always much interested in the work of the Indian Section, particularly in all endeavours to accelerate and extend industrial development in our Eastern Empire. He paid special attention to the improvement of the inland waterways of Bengal and Assam, and took part in the discussion which followed the reading of an important paper on the subject by Mr. R. B. Buckley, C.S.I., in 1906.

NOTES ON BOOKS.

NOTES ON CARPET-KNOTTING AND WEAVING. London: H.M. Stationery Office. 9*d.* net.

This small pamphlet, issued under the direction of the Department of Textiles at the Victoria and Albert Museum, may be taken as a supplement to a larger and more important "Guide to the collection of Carpets" published by the same Department in 1915. It deals with the technique of hand knotted and hand woven carpets of the kind so largely made during many centuries in Persia, Turkey, and other countries in the East. The main purpose of the author, Mr. C. E. C. Tattersall, of the Victoria and Albert Museum, it would appear, is to give information to those who may be led to attempt carpet making for themselves. For this purpose the booklet contains a number of plates illustrating in diagrammatic form the various knots in use in the Orient. In principle they are

chiefly two, the one known as the "Ghiordes" or "Turkish" knot, the other the "Sehna" or "Persian" knot. Mr. Tattersall furthermore deals with the Oriental tapestry weave, and more particularly illustrates the one which is used in the manufacture of the "Soumak" (Caucasian) carpet. The illustrations on "Selvedges," always so important in the life of a carpet, give very useful information how selvedges should be worked and finished, whilst the information contained in the illustrations of fringes on the ends of carpets and rugs form an instructive lesson on the finished article.

The authorities at South Kensington are doing a good service in their effort to encourage the manufacture of rugs and carpets. We cannot, however, imagine they advocate a revival of hand-knotted carpets and rugs as an industry. Such a proposition in our opinion is doomed to failure; the cost of labour would alone make it impossible of success in this country. If, on the other hand, it is their idea that gentlefolk should take up the work as a pastime or recreation, thus enabling them to make rugs as part of their dowry, just as in the East every girl is a knotter and weaver of rugs; or if, to develop the idea a step further, the learning of such an industry may, in their judgment, be the means of producing very fine grades of rugs of very special designs, which might command a market amongst the more wealthy in our land—then the idea is a good one, and with the co-operation of wool spinners who may see their way to stock suitable yarns, the scheme has some possibilities of success.

Coming from the Museum, the booklet makes no pretence to instruct one on all that has to be learnt about rug-making, a task which belongs more to the Schools of Art.

The introduction of a "William Morris" carpet loom, which figures at the end of the booklet, will help the reader to judge how simple and inexpensive is the machinery needed to outfit the would-be rug-maker.

On the whole, the pamphlet should form an adjunct to text-books on the craft industries, applicable alike to the technical side of Schools of Art and to the workshops of the machine-made carpets.

As Mr. Tattersall has made almost microscopical examinations on knots in use in Turkey and Persia, we commend for his further investigation an interesting problem, viz., to trace the influence or the migration of the "Turkey" knot in Eastern Persia, Central Asia, Afghanistan and India, and to try to explain how the "Turkey" knot came to be used in countries where one would expect the "Persian" knot to have been paramount.

GENERAL NOTES.

Victoria and Albert Museum. — By the generosity of a body of subscribers, substantially aided by the National Art-Collections Fund, the Victoria and Albert Museum has acquired a specimen of one of the rarest and most keenly sought of early Chinese porcelains—the celebrated Chün ware of the Sung dynasty. Hitherto, though more than one American museum can show examples of this beautiful ware, in England it could be studied only in private collections. This new addition to the treasures of the nation is a shallow bowl for growing bulbs in of the finest quality. It is of the usual form with three small feet and, round the side, a row of studs in relief. The glaze on the outside belongs to the class of "transmutation" glazes, with variegated colouring produced solely by skilful management of the firing, imitated in the well-known *rouges flambés* of the eighteenth century; its colour is predominantly crimson, with curd-like flecks of bluish-white and passages of fiery rose. The inside is covered with a cloudy greyish-lavender glaze showing where contraction has occurred in the firing the so-called "earthworm" markings characteristic of early wares of this type. The under side has a brown glaze with olive-green markings, and bears the numeral *t'ai* (7), indicating the size of the vessel, cut through the glaze before firing; it also displays another feature of the true Chün porcelain, a ring of scars left by the breaking away of the "stilts" or "cockspurs" used for support in the kiln.

Production of Raggee Flour in Malaya.—Owing to the shortage of rice, the Government of the Federated Malay States obtained legislative powers for the compulsory growing of foodstuffs for the labourers. The foodstuffs cultivated included raggee, hill paddy, and sweet potatoes. In the case of raggee, reports the United States Consul-General at Singapore, a recent demonstration made on the Golconda rubber estate, Kapar, showed that by the use of machinery raggee flour could be satisfactorily produced, and that it would pay planters to grow enough for their own requirements, or to buy locally grown raggee as a substitute for part of the rice they purchase at present. It has been suggested, as a result of the success of the Golconda demonstration, that planters in a district should combine and have one central place for the preparing of their raggee. Malaya, as a whole, has relied almost entirely on outside sources for its supplies of food, and the rice shortage has come as a blessing in disguise, by turning the attention of both the Government and the people to making that country more or less self-contained as far as food supplies are concerned.

THE LIBRARY.

The following books have been presented to the Library since the last announcement. Except where otherwise stated they have been presented by the publishers:—

Andrews, S. T. G., B.Sc., and S. F. Benson, B.Sc.—The Theory and Practice of Aeroplane Design. London: Chapman & Hall, Ltd., 1920.

Baker, Richard T.—The Hardwoods of Australia and their Economics. Sydney: W. A. Gullick, 1919.

Beaumont, Roberts, M.Sc., Union Textile Fabrication. London: Sir Isaac Pitman & Sons, Ltd., 1920.

Bolton, Arthur T., F.S.A.—Description of Sir John Soane's Museum. Tenth Edition, 1920.

Burrow, Edward J.—The Ancient Entrenchments and Camps of Gloucestershire. Cheltenham: Edward J. Burrow & Co., Ltd., 1919.

Cahen, Edward, A.R.C.S., F.I.C., and William Ord Wootton, A.R.C.S., B.Sc.—The Mineralogy of the Rarer Metals. Second Edition. London: Charles Griffin & Co., Ltd., 1920.

Calcutta, Imperial Library—First Supplement to Author-Catalogue of European Books. Two Vols. Calcutta, 1917 and 1918.

Campbell, William.—Modern Business and its Methods. London: Sir Isaac Pitman & Sons, Ltd., 1919.

Clark, Alice.—Working Life of Women in the 17th Century. London: George Routledge & Sons, Ltd., 1919.

Currencies after the War. Compiled by the International Secretariat of the League of Nations. Harrison & Sons, 1920.

Darling, Charles R.—Pyrometry. London: E. & F. N. Spon, Ltd., 1920.

Daw, Albert W., and Zacharias W. Daw.—Compressed Air Power. London: Sir Isaac Pitman & Sons, Ltd., 1920.

De Forcrand, Professeur R.—Cours de Chimie. Deuxième Édition. Deux Volumes. Paris: Gauthier-Villars et Cie., 1918 and 1919.

Filow, Dr. Bogdan D.—Early Bulgarian Art. Berne: Paul Haupt, 1919.

Fisk, Harvey E.—English Public Finance. New York: Bankers Trust Co., 1920.

Groves, E. J. A.—A Junior French Course. London: Blackie & Son, Ltd., 1919.

Hall, H. R. Wilton.—Social Life in England. Blackie & Son, Ltd., 1920.

Hardie, Martin, A.R.E.—Catalogue of Modern Wood-Engravings in the Victoria and Albert Museum, 1919.

Harvey, Arthur.—Practical Leather Chemistry. London: Crosby Lockwood & Son, 1920.

Hayward, F. H., D.Lit., M.A., B.Sc.—A Second Book of School Celebrations. London: P. S. King & Son, Ltd., 1920.

Henry, Augustine, M.A., F.L.S.—Forests, Woods and Trees in Relation to Hygiene. London: Constable & Co., Ltd., 1919.

Howard, Alexander L.—A Manual of the Timbers of the World. London: Macmillan & Co., Ltd., 1920.

Johnson, V. E., M.A.—Model Aeroplaning. London: E. & F. N. Spon, Ltd., 1920.

Lawson, F. M.—Industrial Control. London: Sir Isaac Pitman & Sons, Ltd., 1920.

Lempfert, R. G. K., M.A., C.B.E.—Meteorology. London: Methuen & Co., Ltd., 1920.

Makower, W., D.Sc., et H. Geiger, Ph.D.—Mesures Pratiques en Radioactivité. Traduit de l'Anglais par E. Philippi. Paris: Gautier-Villars et Cie, 1919.

Malatesta, Dr. G., Coal-Tars and their Derivatives. London: E. & F. N. Spon, Ltd., 1920.

Martin, Edward A., F.G.S.—Life in a Sussex Windmill. London: Allen & Donaldson, Ltd., 1920.

Moureu, Charles, Professeur au Collège de France. —Notions Fondamentales de Chimie Organique. Sixième Édition. Paris: Gauthier-Villars et Cie, 1919.

Müller-Lyer, Dr. F.—The History of Social Development. Translated by Elizabeth C. Lake and H. A. Lake, B.Sc. London: George Allen & Unwin, Ltd., 1920.

Napier, Robert W.—John Thomson of Duddingston. Landscape Painter. Edinburgh: Oliver & Boyd, 1919. Presented by the Author.

Penger, N. M., B.A.—Cotton in British West Africa. London: Federation of British Industries, 1920.

Pool, Rev. John J., Ph.D., B.Sc.—Colour and Health. London: Cope & Fenwick, 1919.

Price, J. B., M.A.—A Spanish Reader, 1919.

Rawlley, Ratan C., M.A., M.Sc.—Economics of the Silk Industry. London: P. S. King & Son, Ltd., 1919.

Roget, F. F.—Altitude and Health. London: Constable & Co., Ltd., 1919.

Rose, W. N.—Mathematics for Engineers. London: Chapman & Hall, Ltd., 1920.

Routley, John.—Business Book-keeping. London: Sir Isaac Pitman & Sons, Ltd., 1919.

Russell, Thomas.—Commercial Advertising. London: G. P. Putnam's Sons, Ltd., 1919.

Shanahan, E. W., M.A., D.Sc.—Animal Foodstuffs —their Production and Consumption. London: George Routledge & Sons, Ltd., 1920.

Sykes, Miss Ella and Brigadier-General Sir Percy Sykes, K.C.I.E., C.B.—Through Deserts and Oases of Central Asia. London: Macmillan & Co., Ltd., 1920.

Tanner, Fred Wilbur, M.S., Ph.D.—Bacteriology and Mycology of Foods. London: Chapman & Hall, Ltd., 1919.

Tiffany, Frank.—The Timber Merchant's Handbook. London: William Rider & Son, Ltd., 1920.

Tinkler, C. Kenneth, D.Sc., F.I.C., and Helen Masters, B.Sc.—Applied Chemistry. Vol. 1. [Water, Detergents, Textiles, Fuel, etc.] London: Crosby Lockwood & Son, 1920.

Wall, Howard.—The Story of the Evolution of British Measures. London: Talbot & Co., 1919.

White, Arthur V.—Water Powers of British Columbia. Ottawa, 1919. Presented by the Commission of Conservation, Canada.

Woolf, E. Alec, D.Lit.—A Spanish Course—Literary and Commercial. London: Edward Arnold, 1919.

Wright, Marie Robinson.—The New Brazil. Second Edition. Philadelphia: George Barrie & Sons.

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FRIDAY, OCTOBER 8, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

INDIAN SECTION.

SPECIAL MEETING.

On FRIDAY, OCTOBER 15th, MR. THOMAS M. AINSCOUGH, O.B.E., His Majesty's Senior Trade Commissioner in India and Ceylon, will read a paper on "British Trade with India."

The chair will be taken at 4.30 p.m. by SIR CHARLES C. MCLEOD.

EXAMINATIONS, 1920.

Perhaps the most remarkable feature of the academic year 1919-20, was the enormously increased demand for educational facilities of every description. Universities, technical colleges, day schools and evening schools were suddenly called upon to provide accommodation for far larger numbers of students than they had ever housed before. The principal causes were twofold, one temporary, the other permanent. In the first place, a great many students were anxious to complete their courses of study which had been interrupted by the war; and in the second place, owing to the Fisher Act, and a more general recognition of the necessity for education, a greater proportion of the rising generation are aiming at a higher standard of education than that which contented their fathers.

One of the effects of these causes is shown in a remarkable way in the statistics of the Society's Examinations. It will be seen from the diagram on page 740 that the total number of papers worked rose from 31,132 in 1919 to 49,390 in 1920—an increase of about 60 per cent. These increases occurred in almost every subject of examination, but the most noticeable were in Book-keeping, where the number of papers rose from 9,151 in 1919 to 15,241 in 1920, and in Shorthand, where the number of papers rose from 8,202 to 12,411.

The usual examinations were held at two periods, March and May, as has been the case since 1915. In March, the number of entries was 17,684, and in May, 36,357. The papers worked were divided between the two examinations as follows:—

	March.	May.	Total.
Advanced Stage .	1,642	5,421	7,063
Intermediate Stage	5,102	13,514	18,616
Elementary Stage	9,497	14,132	23,629

In addition to the 49,390 papers worked in the written examinations, 431 candidates presented themselves for the *viva voce* examinations in modern languages, making a total of 49,821.

The principal changes in the examinations programme for 1920 were the discontinuance (for reasons given in the last Report *) of English for Foreigners, Rudiments of Music, and Harmony. There will, however, be some important changes in the Programme for 1921, to which attention is drawn on page 738. The subjects of examination this year were:—Arithmetic, English, Book-keeping, Shorthand, Précis-writing, Typewriting, Economic Geography, Economic History, Economic Theory, Commercial Law, Company Law, Accounting, Banking, Theory and Practice of Commerce, Commercial Correspondence and Business Knowledge, French, German, Italian, Spanish, Russian, Dutch, Danish and Norwegian, Portuguese, and Swedish.

In Arithmetic the total number of papers worked was 3,988, as compared with 2,814 last year. 130 candidates entered in Stage III., of whom 18 obtained first-class certificates, 44 obtained second-class certificates, and 68 failed. The Examiner reports that while some excellent papers were worked in this Stage, the results on the whole were poor. About half the

* See *Journal* of November 7th, 1919, page 780.

candidates were not nearly up to the standard, many of them being unable to answer a simple question in logarithms. Unfortunately, his report on the work in Stage II. is still more unfavourable. Of 1,022 candidates 59 obtained first-class certificates, 383 obtained second-class certificates, and 580 failed. Style and accuracy were worse than in the Stage I. papers, and the great majority of the candidates were quite unprepared in the subject-matter of the syllabus. In Stage I., of 2,836 candidates, 1,819 passed and 1,017 failed, and the examiner was on the whole satisfied with the work of these students.

It is gratifying to note that the number of candidates in English rose from 1,169 in 1919 to 3,351 this year. Part of the increase is no doubt attributable to the fact that English was one of the subjects of competition for the *Daily Sketch* prizes.* In Stage III. there were 88 candidates of whom 10 obtained first-class certificates, 43 obtained second-class certificates, and 35 failed. In Stage II., of 1,237 candidates, 185 obtained first-class certificates, 711 obtained second-class certificates, and 341 failed. In Stage I., of 2,026 candidates, 1,367 passed and 659 failed. The Examiner reports a slight general improvement in the work in Stages I. and II. He criticises the work submitted in considerable detail, and his remarks should be studied with great care, both by students and teachers.

Reference has already been made to the very large increase in the number of candidates in Book-keeping—15,241, as compared with 9,151 last year. In Stage III., of 2,772 candidates, 351 obtained first-class certificates, 1,287 obtained second-class certificates, and 1,134 failed. In Stage II., of 5,648 candidates, 768 obtained first-class certificates, 3,608 obtained second-class certificates, and 1,272 failed. In Stage I., of 6,821 candidates, 4,161 passed, and 2,660 failed. The Examiner points out that in Stages I. and II., even when the exercises are well worked, the answers to the questions are often exceedingly poor, and some of the specimens which he quotes are simply nonsensical.

Shorthand, as usual, comes next to Book-keeping in popularity. The entries totalled 12,411, as compared with 8,202 in 1919. 990 candidates entered for Stage III., of whom 57 obtained first-class certificates, 386 obtained second-class certificates, and 547 failed. 6,152 entered for Stage II.; of these 917 obtained first-class certificates, 2,344 obtained second-class certificates, and 2,891 failed. 5,269 entered in Stage I., and of these 3,913 passed, while 1,356 failed.

In Typewriting, the entries rose from 3,011 in 1919 to 4,634 this year. Of these 428 entered for Stage III.: 137 secured first-class certificates, 154 secured second-class certificates, and 137 failed. In Stage II. there were 1,639 candidates, of whom 508 obtained first-class certificates, 698 obtained second-class certificates, and 433 failed. In Stage I. 2,567 entered, of whom 1,799 passed and 768 failed. The work, on the whole, appears to have been quite satisfactory, although in commenting on the work in Stage I., the Examiner mentions that many centres are turning out operators "regardless of everything but the ability to operate a typewriter with more or less skill." It is obviously useless to train as typists boys and girls who "cannot spell the most elementary words correctly, and are ignorant of the elements of English composition."

The number of entries in Précis-writing is still small. There were only 122 candidates in all, as compared with 100 last year. 34 entered in Stage III., and of these 5 obtained first-class certificates, 19 obtained second-class certificates, and 10 failed; while in Stage II. of the 88 candidates 10 obtained first-class certificates, 49 obtained second-class certificates, and 29 failed. Considerable changes have been made in the Syllabus for 1921, and it is hoped that these may render the examination more popular and more practically useful.

The entries in Accounting made a remarkable increase to 582, as compared with 179 last year. 74 obtained first-class, 335 obtained second-class certificates, and 173 failed. The Examiner reports that the general average of the work showed an improvement on that of 1919, although the percentage of first-class certificates was a little lower. In Banking there were 75 entries, as compared with 26 last year: 8 obtained first-class and 34 obtained second-class certificates. Several excellent papers were sent in, evidently by candidates with sound practical knowledge.

In Economic Geography the total number of entries rose from 202 last year to 275: 31 entered in Stage III., 76 in Stage II., and 168 in Stage III. It is satisfactory to learn that the Examiner reports considerable improvement in the work in all three stages. Similarly, in Economic History the entries rose from 47 in 1919 to 92—23 in Stage III. and 69 in Stage II. According to the Examiner, the work

* See page 738, below.

submitted in Stage III. was very markedly better than that in Stage II., which was generally of a poor character, only 3 candidates out of 69 securing first-class certificates.

183 candidates entered in Economic Theory, as against 82 last year. 79 sat for Stage III., and 104 for Stage II. The Examiner's report shows that the work, on the whole, was quite satisfactory, although in Stage III. out of the 79 candidates only 4 obtained first-class certificates.

The entries in Commercial Law rose from 95 in 1919 to 429 this year. The papers reached an unusual standard of excellence, no fewer than 131 candidates obtaining first-class certificates, while 230 obtained second-class certificates, and only 68 failed. There was a similar increase in Company Law, where the entries rose from 85 to 278; and here, too, the Examiner reports very favourably on the general standard of the work submitted.

In Theory and Practice of Commerce the numbers have also risen satisfactorily from 215 last year to 566, of whom 142 entered in Stage III., and 424 in Stage II. In both examinations there appears to have been a very decided improvement in the quality of the papers.

The entries in Commercial Correspondence and Business Knowledge rose from 2,402 in 1919 to 3,147. In Stage III. there were 58 candidates, of whom 5 obtained first-class certificates, 21 obtained second-class certificates, and 32 failed. In Stage II. of 710 candidates 33 obtained first-class certificates, 449 obtained second-class certificates, and 228 failed. The Examiner comments on the large proportion of successful candidates in this stage, but regrets the absence of papers of real distinction. In Stage I. there were 2,379 candidates, of whom 1,577 passed and 802 failed.

In French there was a satisfactory advance in the numbers from 2,427 in 1919 to 3,058. Of these 740 entered for Stage III.; 1,168 for Stage II.; and 1,150 for Stage I. The Examiner reports very favourably on the work in each Stage, and comments on the small proportion of failures—157 in Stage III., 171 in Stage II., and 258 in Stage I.

The entries in German (252) show a slight increase on those of last year (202), but this subject has by no means recovered the popularity which it lost on the outbreak of the war. In 1914 the total number of entries was 826, and this fell to 181 in 1918. The standard of work in Stage III. was exceptionally high: out of 62 candidates 25 obtained first-class certificates, and only 5 failed.

There were 77 entries in all stages of Italian, as compared with 47 last year.

The popularity of Spanish continues to grow, the entries being 551 as compared with 386 last year, which was the previous highest figure. Unfortunately, the quality of the work submitted leaves a good deal to be desired. Out of 83 candidates in Stage III. only 4 obtained first-class certificates, while in Stage II. out of 210 candidates only 26 obtained first-class certificates.

It is curious to observe how the number of entries in Russian has varied with the fortunes of that unhappy country. In 1917 there were 266 candidates; in 1918 the number fell to 157; in 1919 there were 79, and this year only 56. The Examiner reports that the work in Stage I. is distinctly better than last year.

In Danish and Norwegian there were only 3 candidates, as against 14 last year; in Dutch 7 as against 4; in Portuguese 7, and in Swedish 5. In the last two subjects no examinations had been held for some years.

Oral examinations were held in French, German, Italian, Spanish and Russian. The total number of candidates was 431 (as compared with 351 last year), and examinations were held at Coventry, Liverpool, Manchester and York, as well as at the usual London centres. The numbers in the different languages were: French 351, German 36, Italian 5, Spanish 37, Russian 2. The details of the results of the oral examinations are given in Table B (page 741).

The Court of the Clothworkers' Company have again renewed their grant of £40, to be expended in providing medals in all the subjects of examination where the work of candidates attains a sufficiently high standard. There is no doubt that these medals are highly valued by those who win them, and they have done much to maintain or raise the level of excellence in the papers worked.

The Examination Syllabus for 1921* has been issued. In it will be found the fullest possible information about the examinations, a syllabus of each stage of each subject, and a list of centres. The papers set in March and May, 1920, have been reprinted in six pamphlets.

* The price of the Syllabus for 1921 is 4*d*., post free. Copies can be obtained on application to the Examination Officer, Royal Society of Arts, Adelphi, London, W.C. (2). The price of the pamphlets containing the 1920 papers is 4*d*. each, post free. Particulars of these may be obtained as above.

Each pamphlet contains, in addition to the papers of each stage, the syllabuses of the subjects in the pamphlet and the Examiners' reports on the papers worked in 1920. The attention of both teachers and students may be drawn once more not only to the syllabuses but also to the remarks of the various examiners on the results of last year. It will be found that these contain many valuable and helpful suggestions, and the work of the candidates year after year shows that far too little attention is paid to them. Teachers especially are earnestly recommended to study these reports, as they ought to be guided by them in the instruction they give to their pupils.

The regulations for the Oral Examinations in Modern Languages are also given at full length in the syllabus.

Alterations in the Syllabuses.

The Council have given careful attention to the syllabuses in the various subjects of examination. These have been revised by small curriculum committees, on which every effort has been made to secure the representation of teachers. A considerable number of alterations have been made, which it is hoped will keep the syllabuses in line with the most modern educational requirements. It is impossible in this report to mention all the changes in the syllabuses, of which students and teachers are recommended to make a careful study; but attention may be called to the more important alterations.

Oral Examinations in Foreign Languages.—As stated in the Syllabus for 1920, Vivâ Voce Examinations will be compulsory in 1921 and thereafter for all candidates entering for French, German, Spanish and Italian in Stage III. (Advanced). The Oral Examinations will include Conversation, Reading, and Dictation, and will be held on dates subsequent to the written Examinations. No candidate will be awarded a certificate who does not pass in this part of the test. Candidates will be grouped together for the Oral Test at various centres, and those residing at outlying districts must be prepared to travel some distance.

English (*Stage II.*).—In future candidates will be required to have some knowledge of two prescribed books. For 1921 these will be Shakespeare's "The Tempest," and Scott's "Quentin Durward."

Shorthand (*Stage I.*).—The speed in this stage will be 60 words per minute, instead of 50 words per minute as heretofore.

Arithmetic (*Stage I.*).—Two papers will be set in this Stage, the first being designed as a test of "Mental Arithmetic," while the second will be of the same type as those set in recent years.

Précis-writing.—In future there will be a much greater variety in the materials set than in former years, and candidates will no longer be required to draw up schedules of correspondence.

Railway Law and Practice and *Shipping Law and Practice* have been added to the subjects of examination in Stage III.

Increase of Fees.

In order to raise the fees paid to the Examiners which still remain on their pre-war basis, and to meet the greatly increased cost of printing and paper, it has been found necessary slightly to raise the fees paid by candidates. In future these will be as follows:—

Stage III. (Advanced): 4*s.* per subject, except for French, German, Spanish and Italian for which the fee will be 7*s.* per subject.

Stage II. (Intermediate): 3*s.* 6*d.* per subject.

Stage I. (Elementary): 2*s.* 6*d.* for the first subject, and 2*s.* for each additional subject taken by the same candidate.

"Daily Sketch" Prizes.

It was announced in last year's Report that in order to encourage the study of Typewriting and Shorthand, and to assist in ensuring the supply of efficient and educated shorthand typists, the Proprietors of the *Daily Sketch* had offered a sum of £1,000 in prizes in connection with the Society's Examinations in 1920. In the Advanced Stage the prizes amounted to £675, the first prize being £250; in the Intermediate Stage the prizes amounted to £250, the first prize being £60; and in the Elementary Stage the prizes amounted to £75, the first being £10. The subjects of examination in each stage were Typewriting, Shorthand, and English. These were taken at the Society's ordinary examinations in March and May. In the Elementary Stage the prizes were awarded on the result of these examinations without any further test. In the Advanced and Intermediate examinations a number of candidates were selected to compete for the prizes. The final test was held, by kind permission of the Director of Education, at the Polytechnic, Regent Street, on September 25th, when 25 selected candidates presented themselves, 12 in Stage III., and 13 in Stage II. The results have now been communicated to the proprietors of the *Daily Sketch*, and the list of prize-winners will be published in the *Journal* shortly.

TABLE A.—DETAILS OF THE 1920 EXAMINATIONS.

SUBJECTS.	STAGE III.—ADVANCED.				STAGE II.—INTERMEDIATE.				STAGE I.—ELEMENTARY.			Total number of Papers worked in all Stages.	
	Papers worked.	1st-class certificates.	2nd-class certificates.	Not passed.	Papers worked.	1st-class certificates.	2nd-class certificates.	Not passed.	Papers worked.	Passed.	Not passed.	1920.	1919.
Arithmetic	130	18	44	68	1,022	59	383	580	2,836	1,819	1,017	3,988	2,814
English	88	10	43	35	1,237	185	711	341	2,026	1,367	659	3,351	1,169
Book-keeping	2,772	351	1,287	1,134	5,648	768	3,608	1,272	6,821	4,161	2,660	15,241	9,151
Economic Geography	31	2	18	11	76	8	35	33	168	109	59	275	202
Shorthand	990	57	386	547	6,152	917	2,344	2,891	5,269	3,913	1,356	12,411	8,202
Typewriting	428	137	154	137	1,639	508	698	433	2,567	1,799	768	4,634	3,011
English for Foreigners	—	—	—	—	—	—	—	—	—	—	—	—	93
Economic History	23	2	19	2	69	3	46	20	—	—	—	92	47
Economic Theory	79	4	54	21	104	23	57	24	—	—	—	183	82
Précis Writing	34	5	19	10	88	10	49	29	—	—	—	122	100
Commercial Correspondence and Business Knowledge	58	5	21	32	710	33	449	228	2,379	1,577	802	3,147	2,402
Commercial Law	429	131	230	68	—	—	—	—	—	—	—	429	95
Company Law	278	87	151	40	—	—	—	—	—	—	—	278	85
Accounting	582	74	335	173	—	—	—	—	—	—	—	582	179
Banking	75	8	34	33	—	—	—	—	—	—	—	75	26
Theory and Practice of Commerce	142	15	101	26	424	43	284	97	—	—	—	566	215
French	740	157	426	157	1,168	350	647	171	1,150	892	258	3,058	2,427
German	62	25	32	5	80	13	47	20	110	64	46	252	202
Italian	22	2	13	7	24	1	15	8	31	20	11	77	47
Spanish	83	4	56	23	210	26	111	73	258	157	101	551	386
Russian	16	4	7	5	23	10	10	3	17	12	5	56	79
Danish and Norwegian	—	—	—	—	3	2	—	1	—	—	—	3	14
Dutch	—	—	—	—	7	2	1	4	—	—	—	7	4
Portuguese	—	—	—	—	7	3	1	3	—	—	—	7	—
Swedish	—	—	—	—	5	—	3	2	—	—	—	5	—
Rudiments of Music	—	—	—	—	—	—	—	—	—	—	—	—	73
Harmony	—	—	—	—	—	—	—	—	—	—	—	—	27
Totals, 1920	7,062	1,098	3,430	2,534	18,696	2,964	9,499	6,233	23,632	15,890	7,742	49,390	—
Totals, 1919	3,310	471	1,621	1,218	11,670	1,638	5,945	4,031	16,152	10,508	5,644	—	31,132

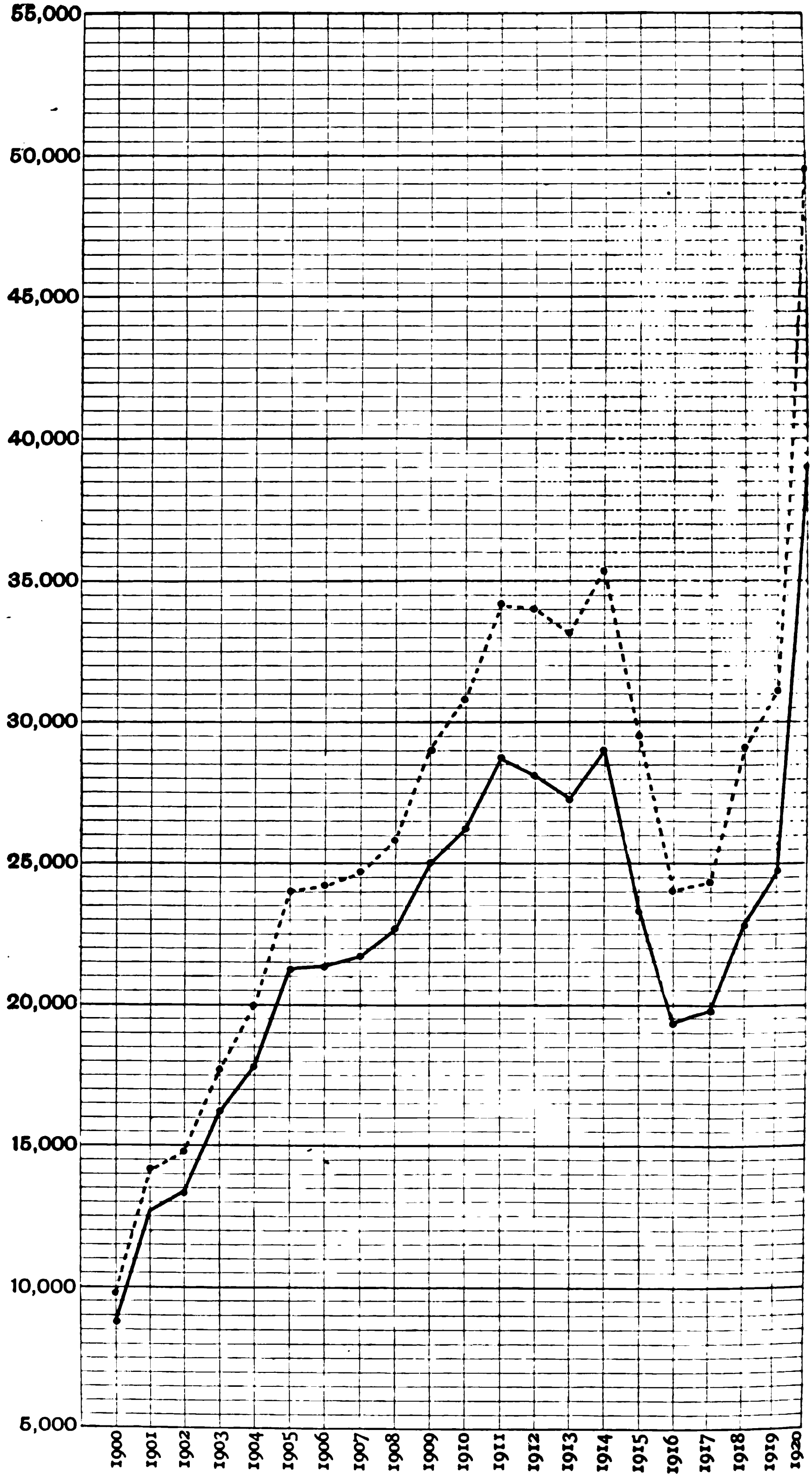

DIAGRAM SHOWING PROGRESS OF EXAMINATIONS, 1900-1920.
The continuous line shows the number of candidates, the dotted line the number of papers worked.

TABLE B.

ORAL EXAMINATIONS HELD DURING 1920.

Centre of Examination.	Date.	Number of Candidates.	Passed with Distinction.	Passed.	Failed.
French:—	1920.				
Coventry Municipal Technical Institute	May 4	24	3	15	6
Manchester High School of Commerce	May 13	17	6	11	—
Enfield Technical Institute	May 18 & 19	58	4	37	17
York Education Committee	May 19	21	1	5	15
Kensington College	May 26 & June 2	32	7	15	10
Acton and Chiswick Polytechnic	May 28	15	4	6	5
City of London College	June 3	32	5	19	8
Pitman's School	June 7 & 8	41	12	20	9
Liverpool City School of Commerce	June 9	22	10	12	—
Regent Street Polytechnic Institute	June 10 & 11	32	11	13	8
"Oliver Goldsmith" L.C.C. Commercial Institute	June 21	20	3	14	3
"Hugh Myddelton" L.C.C. Commercial Institute	June 22 & 23	37	10	17	10
German:—					
Manchester High School of Commerce	May 14	10	2	8	—
City of London College	June 24	12	2	4	6
Regent Street Polytechnic Institute	June 29	14	6	4	4
Spanish:—					
Pitman's School	June 17	15	—	9	6
City of London College	June 25	22	3	11	8
Italian:—					
City of London College	June 30	5	—	5	—
Russian:—					
City of London College	June 28	2	—	2	—
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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

RECENT RESEARCH IN CELLULOSE INDUSTRY.

By CHARLES FREDERICK CROSS, B.Sc., F.R.S.

Lecture III.—Delivered March 1st, 1920.

PROBLEMS OF CONSTITUTION.

Students of "organic" chemistry are warned, generally in the opening chapter of the systematic text-books, of the errors of our forefathers in treating "organic compounds" as an inaccessible group of bodies, formed and supplied exclusively as products of life, *i.e.*, of the plant or animal cell. It appears necessary, as a retrospect, to eliminate from the natural philosophy of the subject, an error or superstition of the "old school"; as a matter of history the modern science has developed largely by way of synthesis of "organic" chemical individuals incidentally detached from theories of life, and animated by an objective spirit of research. The results appear to justify the philosophy. It is, however, a feature of science progress that the errors of a school or generation in regard to phenomena, are recognised at a later period as an adumbration of an essential aspect of generalised causes. Thus, "phlogiston" suggests the energy factor of reaction, and Newton's treatment of Light has some suggestions of modern discoveries which go behind the

theories of Young and their physical consequences.

The subject matter of these lectures is impressive of a definite return to the perspective of Natural History, in the treatment of organic compounds: their fundamental chemistry may be so linked with the biology of the genesis of strictly "organic" compounds—those carbon compounds which are formed as structurally organised bodies—that the progressive investigation of the ultimate structure of these natural products may contribute generalisations affecting the science as a whole.

This is not generally admitted as a probability, though it would be accepted as a possibility, but so remote as to be without influence on the method or scope of investigations, or on the interpretation of their results.

On the concrete problem of the constitution of cellulose, there has grown already an extensive literature. "Cellulose" reacts to form synthetic derivatives: (*a*) nitrates, acetates, benzoates, mixed esters, and hydrate-esters, with quantitative relations such as exactly to measure the reacting groups; (*b*) ether products, of which the methyl and ethyl derivatives have been more closely studied: it is resolved into well-defined proximate products; (*c*) by anhydrous reactions, *e.g.*, bromo-methyl furfural (Fenton), laevoglucosan (A. Pictet); (*d*) an indefinitely varied series of decomposition products, more nearly related to the original cellulose, the oxycelluloses, hydrocelluloses, hydrate-celluloses, resulting from the action of oxidants, hydrolysers, acid and alkaline, and reducing agents, in water as reaction medium, and complicated by hydrations and dehydrations. Lastly, "cellulose" is resolved by bacteria to ultimate products: liquid (alcohols and fatty acids), and gaseous, (CO_2 and CH_4).

All these reactions have been impressed into the service of the investigator of the constitutional problem or problems.

It would be outside our present purpose to attempt a review of the literature of the subject; but we may refer to a recent record of investigations in the best traditions of what we may call the *haute école*, a paper by K. Hess and W. Wittelsbach, with the sub-title "Acetolyse der Ethyl-Cellulose" [Ztschr. Electrochem, 26 (1920) 232-251] abstr. J. Chem. Soc., 1920, i. 532.

This is a close study based on the controlled dissection of the acetylated derivatives (Ost); and in the discussion of results the authors infer that the solvent actions of saline solutions (*e.g.*, $Zn.Cl_2$—M'.CNS) are the result of interaction with the residual valencies which cause the complexity of the "cellulose molecule." It is also noteworthy that the discussion touches the question of the relation of visible structure, *i.e.*, organic form, to constitution, which is provisionally formulated in terms of a monose (dextrose) and a biose (cellobiose).

This is a valuable contribution to the subject, and is representative of a series of investigations which proceed on the accepted "grammatical" methods, which certainly presume their adequacy to solve the major problem.

This mode of attack, however, rules out of consideration a large number of problems which arise in the cellulose industries, whether considered as merely utilising natural raw material, or developing what we may call the "cellulose scheme" or plan of the organic world. This brings us back to the alternative perspective of the subject, that of its natural history, and to the question of the development of industry by the application of "science" in the modern sense.

Robert Boyle (ed. 1725, P. Shaw), has something to say on this general theme. "It may be expected," he writes, "that I should treat particularly of the principal means whereby a *naturalist* might advance *trades* and assist mankind to recover *part* of his lost empire over the works of Nature."

This is a pregnant forecast; and in regard to the present and future development of our subject, it is a fair inference from past progress that the main line of evolution follows "industry"; and reciprocally "industry" will follow science, provided the subject matter is not arbitrarily detached from its natural setting.

The developments in "artificial silk," *et similia* is a case in point, the bearings of which are evident without discussion.

The "viscose reaction" upon which these largely depend is an illustration of the difficulty of the scientific problem. There are two more recent contributions to the development of this section which must be noted.

In "Zellstoffviscose und Starkeviscose" [Annalen, 1911, 382-340-360] Ost (Westhoff and Gessner) investigates the viscose cycle, formation of the xanthogenate and spontaneous reversion in solution, and confirms, on a more extended basis of quantitative results, the first formation of $[C_6H_nO_3(ONa),OCS_2Na]_m$ and reversion through stages of C_{12} and C_{24}, dimensions of analogous products also characterised by an

(ONa) residue in the cellulose. The starch reaction is closely analogous; the xanthogenates are more stable; also the starch complex though apparently progressively hydrolysed, is not resolved to dextrins, but retains the essential properties and characteristics of the original starch. This investigation is based on methods which do not correspond with the factors of instability of the products, and only permit the identification of well-marked phases. It is obviously important to determine whether the reversion is actually "continuous" as it appears to be; and for this a quite special manipulation and detailed technique is required, as well as a full preliminary experience of the various types of cellulose, as such, and of their characteristic behaviour in the "xanthic" reaction cycle.

The "limited viscose reaction" previously mentioned (Lecture II.) has a bearing on the mechanism of the full reaction, giving a basis of independent observation of its hydration factors.

It is well known that the interaction of sodium hydrate (NaOH solutions) and fibrous cellulose is marked by variable "mercerising" effects, the effects of hydration and structural modification. Below 12 per cent. NaOH, at ordinary temperatures, the visible effects are small, and at 9–10 per cent. NaOH the change of dimensions is negligible. But in contact with the reagent, *and* exposed to the bisulphide, there is reaction with production of a fractional proportion of xanthogenate, and some change of dimensions.

Thus a square of bleached cotton cloth was reduced by 33 per cent. in square dimensions, under the reaction in question; in contact with 7 per cent. NaOH, and afterwards under reaction with CS_2, the loss was 7 per cent.

Of the chemical effects, the following data are typical:—

(1) *G. C. Cellulose, Normal Standard.*

In 10 gm. portions (9·3 grms. dry) treated 9 per cent. NaOH, in proportions (*a*) 1·0, (*b*) 1·5, (*c*) 2·0 times its weight, afterwards exposed to CS_2, and the reaction product diffused in water. The following were determined:—

	a	*b*	*c*
Total cellulose in solution,	0·213	0·308	0·224
of which as xanthogenate	0·160	0·255	0·171
Total combined sulphur (xanthogenic ester and by-products) . . .	0·342	0·399	0·366

(2) *G. C. Cellulose.*

Extreme reaction with three times weight, 9 per cent. NaOH. Total cellulose dissolved, 0·614 from 9·3 grms. dry. The fully washed fibrous hydrated mass was treated with an equal weight of mercerising soda (17·5 per cent. NaOH). After diluting and filtering the solution was acidified, and the cellulose precipitate collected and weighed = 4·530 grms.

(3) *Raw Cotton* was profoundly attacked under treatment as follows:—10·0 grms. (a.d.) in the form of sliver, immersed in 9 per cent. NaOH at 100°, immediately removed and squeezed to 30·0 grms. total weight. After reaction with CS_2, washed on vacuum filter. The hydrated mass weighed 170 grms., and correlative with this extreme hydration, the cellulose showed an increased solubility in soda, a 9 per cent. solution dissolved 50 per cent.

Attention has been called to the effects of the hydration in enormously exaggerating the dimensions of the fibre, while conserving its structural details. From the point of view of the chemical effect, it is another example or proof of "continuous reactivity" in or of the cellulose system. This is a statement or conclusion obviously open to discussion. It involves the open question of the reacting unit or "the molecule" as usually defined, and this will be referred to subsequently.

In continuation of the present theme, there are other problems arising out of the industrial application of cellulose, which have a bearing on the deeper problems of constitution; they are only mentioned here, with the reference to the original papers wherein they are recorded and discussed (J. Soc. Dyers and Col. 1918: 215, 247, and 1919, 271). One is the exceptional case of destruction of a normal cotton cloth under the operation of beetling, to a microscopic powder, of a fundamentally modified cellulose. Another is the transformation of an original (untreated) cotton, the cotton yarn of a power-driving rope, to a structureless modification, taking the form of rounded hyaline masses. In either case there were no ascertainable causes of the fundamental changes of the cellulose substance, other than the mechanical-physical conditions of the respective operations. In this connection we refer to the brief description of Professor Robinson's investigation of the changes in lignocellulose structures under compression (R. S. Reports, Nov. 1919).

These are definite indications of fluidity, *i.e.*, a plastic variability of the fibre colloids, and it is in this order of suggestion that we have given attention to the volume-constants of

cellulose and derivatives. One aspect of these specific volumes is the subject of a paper published some years ago (Cross and Bevan, Berl. Ber. 42—1909—2198), and the matter is now under general and methodical investigation by Dr. S. Judd Lewis, as a section of the research scheme of Messrs. Courtaulds, Ltd. The experimental work involved presents exceptional difficulties, and the results require verification by repetition and carefully devised variations. Hence the delays in the publication of results of these extensive researches. They have been previously mentioned and discussed in outline, with the reservations in conformity with the recognised complications of the subject. The results continue to confirm the statements as to: (1) Large variations of apparent density of cellulose and derivatives, with variations of liquid medium, the displacement of which measures the volume; (2) large variations with changes of temperature; (3) general tendency to increase of (specific) volume, in the proximate products of modification, *e.g.*, hydrocelluloses, oxycelluloses, hydrate celluloses.

The principle which has dictated the undertaking of this research is fundamental; in complete ignorance of the ultimate forms of colloidal matter, the transition from parent substance to derivatives, under reaction, requires quantitative observation both of weight *and volume*, as a condition of inference from the derivative to the original substance or system. It is evident that we cannot define, in ultimate terms, what is expressed in specific volume; if we could, we could inferentially pass from starch to cellulose, or even from cellulose to gelatin in the interpretation of reaction changes. But with a given colloid, the volume *relations* of derivatives to original substance are certainly of fundamental import, and in the case of cellulose the neglect of this factor is an obvious weakening of the basis of conclusion as to the "constitution of cellulose," from investigations of derivative products.

This is by no means a criticism, in the sense of an under-estimate of the valuable contributions of experimental work of Ost, Willstätter, König and other representatives of "the School." It is rather limited to the underlying conception of "cellulose." The criticism may be extended to the too exclusive attention to cotton cellulose. Other well-established and differentiated types, more especially (pine) wood cellulose and esparto cellulose, should be studied by parallel investigations. As an illustration we refer to "Esparto Cellulose and the Problem of Constitution" (J. Chem. Soc. 113 (1918), 182). As a general suggestion, in regard to method, it would be important to extend the *scale* of such investigations involving the resolution to more or less ultimate products. Systematic quantitative records, based on the treatment of 1 to 10 kilos of original substance, would eliminate some of the uncertainties which attach to the ordinary laboratory scale of operation.

It is to be observed that systematic investigation of constitutional problems has abandoned the field of observation connoted by *Hydro-, oxy-, hydral-, and acid-cellulose.* These are proximate products of resolutions determined by reactions in presence of water: the products preserving obvious relationships, those of external resemblance, or those of physical characteristics as colloide, to the original cellulose. The complications presented by these series of derivatives are obvious and justify their being ruled out. It is hoped, however, that their inclusion in the scheme of determinations of specific volumes will lead to some general inferences of value, even on the problem of constitution. Attention may be called here to the work of Christian Bay (Dissertation Giessen, 1913) in association with Professor C. Schwalbe, and published under the above title. The investigation of well-defined types of these breakdown products establishes their common characteristics of the more general order, expressed in terms of the "Schwalbe constants." There is an inference to be drawn from this general resemblance of products of oxidation (MOCl and H_2O_2) and of hydrolytic actions of varying order (acid-alkaline) and intensity, viz., that the determining cause of change of the cellulose is rather intrinsic, than determined by the conditions of reaction. This has a bearing on the problem of constitution, but immediately has the value of a criticism of the specific value generally associated with the terms in question —notably "oxy-cellulose" and "hydro-cellulose."

In logical continuation of these destructive resolutions of cellulose, we again briefly mention the fermentations of cellulose, *i.e.*, the breakdown to ultimate products, liquid and gaseous. These are determined by various bacteria: and most effectively and rapidly by mixed organisms—symbiotic cultures. Observers appear to be agreed as to the general absence of intermediate products—products of "hydrolysis"—and that, from microscopic observation, the attack of the organisms is an attack *in situ*. This would accord with our observations of the

general characteristics of "cellulose" as those of a liquid system, and capable of "continuous" reactivity.

These processes are being brought so far under control that the periods required to break down an experimental mass of cellulose have been reduced from weeks (or even months) to days; and comparative observations with starch have demonstrated the equal and, under conditions, greater sensitiveness of the cellulose to the attack of the organisms. This is another of the many indications that the general reactivity of these natural colloids is an expression of positive characteristics rather than of inertness due to molecular complexity of the order of polymerisation.

It is not the purpose of this discussion to attempt any formal conclusions, and we may conclude this section by reminding students that it obviously involves the modern development of the subject of colloidal matter, for an account of which there are the "Reports on Colloidal Chemistry," i., 1917, ii., 1918, of the British Association Committee. And in this connection there may be mentioned the general trend of theory, to account for reaction and reactivity in terms of amphoteric dualism. A notable example of this is in a paper by R. Abegg, "Zur Theorie der Grignard'schen Reaktionen" (Berl. Ber., 1905, 4112), which may well be studied as a model. The applications to cellulose and starch reactions and reactivity are general and obvious. It must be an object of research to apply this method of critical interpretation more specifically. Thus, in Dr. Mary Cunningham's critical study of Willstätter's investigations of cellulose (J. Chem. Soc., 118, 1918, 180), there are incidental observations (1) of the formation of a hydrate-ester by treatment of cellulose with H_2SO_4 $2H_2O$; (2) of a pronounced acid function of constituent OH groups of the cellulose. These indicate a "basic-acid" polarity of cellulose definitely more pronounced than in the case of dextrose or the simple sugars, which are generally assumed, as anhydro-polymerides, to constitute the celluloses.

The problem of constitution is much widened and complicated when extended to the "compound celluloses," of which the prominent typical representatives are the ligno-celluloses and cuto-celluloses, connoting the physiological processes of wood formation, and the production of the external protective tissues of plant structures.

Of the former we have recently dealt in a paper "Lignone reactions and constitution" (J. Soc. Dyers and Col. 1916), and Lecture I. is intended as a definite forecast of progressive research on this subject.

In the cuto-celluloses we have also to refer to a recent publication of research work on a representative cuticularised tissue—the familiar raffia fibre (Cross and Bevan, *ibid.*, 35 (1919), 70). These researches are now extended to the esparto cuticle, which we have been able to separate in quantity, *i.e.*, as a mass of individualised cells, for investigation.

Reverting, in conclusion, to the more general aspect of these constitutional problems, they present themselves, on the one hand, as a section of the general theory of colloidal matter, and on the other as problems of organic growth.

As forms of matter the chemist treats them as such, and independently of origin or of the more general theories of matter. So far there is justification of this attitude; in reviewing the progress of science in this sphere we recognise a basis of empiricism: the test of results.

It is evident, however, that this basis is not permanently adequate, and that future progress must be more definitely assured by adopting the broader perspective of natural history.

INTENSIVE CULTIVATION DURING THE WAR.*

Although the work which intensive cultivators accomplished during the war is small in comparison with the great work performed by British agriculturists, yet nevertheless it is in itself by no means inconsiderable, and is, moreover, significant, and deserves a brief record. That work may have turned and probably did turn the scale between scarcity and sufficiency; for, as I am informed, a difference of 10 per cent. in food supplies is enough to convert plenty into dearth. Seen from this standpoint the war-work accomplished by the professional horticulturist—the nurseryman, the florist, the glass-house cultivator, the fruit-grower and market gardener, and by the professional and amateur gardener and allotment holder assumes a real importance, albeit that the sum total of the acres they cultivated is but a fraction of the land which agriculturists put under the plough.

As a set-off against the relative smallness of the acreage brought during the war under intensive cultivation for food purposes, it is to be remembered that the yields per acre obtained by intensive cultivators are remarkably high. For example, skilled onion-growers compute their average yield at something less than 5 tons to the acre. A chrysanthemum-grower who turned his resources from the production of those flowers to that of onions obtained over an area of several acres, a

* Extracted from the Presidential Address of Professor Frederick Keeble, C.B.E., Sc.D., F.R.S., to the Agricultural Section, British Association, Cardiff.

yield of 17 tons per acre. The average yield of potatoes under farm conditions in England and Wales is a little over 6 tons to the acre, whereas the army gardeners in France produced, from Scotch seed of Arran Chief which was sent to them, crops of 14 tons to the acre. Needless to say, such a rate of yield as this is not remarkable when compared with that obtained by potato-growers in the Lothians or in Lincolnshire, but it is nevertheless noteworthy as an indication of what I think may be accepted as a fact, that the average yields from intensive cultivation are about double those achieved by extensive methods.

The reduction of the acreage under soft fruits—strawberries, raspberries, currants, and gooseberries—which took place during the war gives some measure of the sacrifices—partly voluntary, partly involuntary—made by fruit-growers to the cause of war-food production. The total area under soft fruits was 55,560 acres in 1913, by 1918 it had become 42,415, a decrease of 13,145 acres, or about 24 per cent. As would be expected, the reduction was greatest in the case of strawberries, the acreage of which fell from 21,692 in 1913 to 13,143 in 1918, a decrease of 8,549 acres, or about 40 per cent. It is unfortunate that bad causes often have best propagandas, for were the public made aware of such facts as these they would realise that the present high prices of soft fruits are of the nature of deferred premiums on war-risk insurances, with respect to which the public claims were paid in advance and in full.

I should add that the large reduction of the strawberry acreage is a measure no less of the shortsightedness of officials than of the public spirit of fruit-growers; for in the earlier years of the war many counties issued compulsory orders requiring the grubbing up and restriction of planting of fruit, and I well remember that one of my first tasks as Controller of Horticulture was to intervene with the object of convincing the enthusiasts of corn production that, in war, some peace-time luxuries become necessaries and that, to a sea-girt island beset by submarines, home-grown fruit most certainly falls into this category.

Those who were in positions of responsibility at that time will not readily forget the shifts to which they were put to secure and preserve supplies of any sorts of fruit which could be turned into jam—the collection of blackberries, the installation of pulping factories which Mr. Martin and I initiated, and the rushing of supplies of scarcely set jam to great towns, the populace of which, full of a steadfast fortitude in the face of military misfortune, was ominously losing its sweetness of disposition owing to the absence of jam and the dubiousness of the supply and quality of margarine.

But though the public lost in one direction it gained in another, and the reduction of the soft-fruit acreage meant—reckoned in terms of potatoes—an augmentation of supplies to the extent of over 100,000 tons. Equally notable was the contribution to food production made by the florists and nurserymen in response to our appeals. An indication of their effort is supplied by figures which, as president of the British Florists' Federation, Mr. George Munro—whose invaluable work for food production deserves public recognition—caused to be collected. They relate to the amount of food production undertaken by 100 leading florists and nurserymen. These men put 1,075 acres, out of a total of 1,775 acres used previously for flower-growing, to the purpose of food production, and they put 142 acres of glass out of a total of 218 acres to like use. I compute that their contribution amounted to considerably more than 12,000 tons of potatoes and 5,000 tons of tomatoes.

The market growers of Evesham and other districts famous for intensive cultivation also did their share by substituting for luxury crops, such as celery, those of greater food value, and even responded to our appeals to increase the acreage under that most chancy of crops—the onion, by laying down an additional 4,000 acres and thereby doubling a crop which more than any others supplies accessory food substances to the generality of the people.

In this connection the yields of potatoes secured by Germany and this country during the war period are worthy of scrutiny.

The pre-war averages were: Germany, 42,450,000 tons; United Kingdom, 6,950,000 tons; and the figures for 1914 were: Germany, 41,850,000 tons; United Kingdom, 7,476,000 tons.

Germany's supreme effort was made in 1915 with a yield of 49,570,000 tons, or about 17 per cent. above average. In that year our improvement was only half as good as that of Germany: our crop of 7,540,000 tons bettering our average by only 8 per cent. In 1916, weather played havoc with the crops in both countries, but Germany suffered most. The yield fell to 20,550,000 tons, a decrease of more than 50 per cent., whilst our yield was down to 5,469,000 tons, a falling off of only 20 per cent. In the following year Germany could produce no more than 39,500,000 tons, or a 90 per cent. crop, whereas the United Kingdom raised 8,604,000 tons, or about 24 per cent. better than the average. Finally, whereas with respect to the 1918 crop in Germany no figures are available, those for the United Kingdom indicate that the 1917 crop actually exceeded that of 1918.

There is much food for thought in these figures, but my immediate purpose in citing them is to claim that of the million and three-quarter tons increase in 1917 and 1918 a goodly proportion must be put to the credit of the intensive cultivator.

I regret that no statistics are available to illustrate the war-time food production by professional and amateur gardeners. That it was great I know, but how great I am unable to say. This, however, I can state, that from the day before the outbreak of hostilities, when, with the late Secretary of the Royal Horticultural Society, I started the intensive food-production campaign by urging publicly the autumn sowing of vegetables—

a practice both then and now insufficiently followed —the amateur and professional gardeners addressed themselves to the work of producing food with remarkable energy and success. No less remarkable and successful was the work of the old and new allotment holders, so much so indeed that at the time of the Armistice there were nearly a million and a half allotment holders cultivating upwards of 125,000 acres of land: an allotment for every five households in England and Wales. It is a pathetic commentary on the Peace that Vienna should find itself obliged to do now what was done here during the war—namely, convert its parks and open spaces into allotments in order to supplement a meagre food supply.

This brief review of war-time intensive cultivation would be incomplete were it to contain no reference to intensive cultivation by the armies at home and abroad. From small beginnings, fostered by the distribution by the Royal Horticultural Society of supplies of vegetable seeds and plants to the troops in France, army cultivation assumed under the direction of Lord Harcourt's Army Agricultural Committee extraordinary large dimensions: a bare summary must suffice here, but a full account may be found in the report presented by the Committee to the Houses of Parliament and published as a Parliamentary Paper.

In 1918 the armies at home cultivated 5,869 acres of vegetables. In the summer of that year the camp and other gardens of our armies in France were producing 100 tons of vegetables a day. These gardens yielded, in 1918, 14,000 tons of vegetables, worth, according to my estimate, a quarter of a million pounds sterling, but worth infinitely more if measured in terms of benefit to the health of the troops.

As the result of General Maude's initiative, the forces in Mesopotamia became great gardeners, and in 1918 produced 800 tons of vegetables, apart altogether from the large cultivations carried out by His Majesty's Forces in that wonderfully fertile land. In the same year the forces in Salonika had about 7,000 acres under agricultural and horticultural crops, and raised produce which effected a saving of over 50,000 shipping tons.

IRON INDUSTRY FOR CELEBES.

The Mining Department of the Government of Netherlands India has recently issued a comprehensive report on the possibilities of iron mining and iron and steel manufacture in the island of Celebes, Netherlands India. Government engineers have made extensive preliminary studies and surveys of the entire position, and, according to a report by the United States Consul at Sourabaya, it appears that either the Government or private enterprise will undertake the development of the field in the near future.

The largest ore field to which recent investigations have been directed is that of Celebes in the Larona district, lying near Towoeti Lake. The survey of this field showed 160,000,000 tons of ore, containing an estimated iron content of 5,000,000 tons; and there is believed to be 5,700,000 tons of iron in an additional 210,000,000 tons of ore that have not yet been completely surveyed and tested. This field holds the best promise for early results, since it lies within twenty-five miles of a deep-water bay on the coast, and may be very largely worked by electric power, which can be generated from several waterfalls along the Larona River. The Larona flows from Towoeti Lake to the sea, descending about 300 metres in twenty miles; about 200 metres of the fall occurs within a length of about eight miles. In this distance it will be possible to utilise four falls of approximately 45, 25, 30, and 80 metres respectively. There is also a possibility of utilising other falls of about 25 metres above those mentioned, as well as falls below of an additional 50 to 60 metres.

Computing the natural overflow from the Towoeti, Mahalona, and Matano Lakes, together with the average rainfall draining into the river, it is estimated that 2,610,000,000 cubic metres of water are carried annually by the Larona, or an average volume of 83 cubic metres per second. Having the lakes as natural reservoirs for retaining the heavy rainfall of the rainy season through the dry season, the rate of at least 80 cubic metres per second should be maintained throughout the year. It is then estimated that turbines situated at the four points along the river, and utilising the average flow of 80 cubic metres per second, will develop 144,000 horse-power.

Practically the whole ore field lies on or very close to the surface, the purest ore being on the top, so that the working should be possible at a minimum cost. The ore vein over the entire field varies in depth from 4 to 22½ metres, the average depth, calculated from forty-three widely-separated drillings, being 11·6 metres. The iron content of the ore varies from about 45 to 50 per cent. The average of nine analyses shows the iron content to be 50·55 per cent., while the manganese content is 1·19 per cent., and nickel 0·38 per cent. Rather incomplete analyses as to the sulphur content indicate about 0·14 per cent.

CORRESPONDENCE.

SYNTHETIC DRUGS.

Dr. J. J. Acworth has drawn my attention to an error in my third Cantor Lecture on page 646 of the *Journal* of August 20th. Adrenalin and Epinene raise blood pressure; Ergamine lowers it. Please, therefore, substitute for the paragraph "An artificial drug . . . may be noted" the following:—

"An artificial drug, having much the same action as adrenaline, has been introduced under the name of *Epinene* (3:4—Dihydroxyphenylethylmethylamine, Pyman, *Trans. Chem. Soc.*, 1910, 97, 272); a recent technical synthesis of adrenaline may be noted (Nagai, Brit. Pat. 118298).

"Whereas the blood pressure is raised by adrenaline and epinene, it is lowered by β—Iminazolylethylamine (*Ergamine*, Burroughs & Wellcome)."

J. T. HEWITT.

NOTES ON BOOKS.

HANDBOOK OF COMMERCIAL INFORMATION FOR INDIA. By C. W. E. Cotton, I.C.S. Calcutta: Superintendent of Government Printing, India. 2s.

The author of this extremely useful compilation is the Collector of Customs in Calcutta. Such a work was greatly needed for, as Mr. Cotton observes, "India is so vast and so remote that there is no doubt that on the Continent and in America, if not in the United Kingdom"—where, of course, it is less excusable—"abundant ignorance prevails with regard to the commercial geography of the country and her trade potentialities." The idea of the Handbook was suggested by Mr. Chadwick, Indian Trade Commissioner in London, obviously as the result of his commercial missions to France, Italy, and Russia, as well as of his experience in England. He pointed out that valuable as are Sir George Watt's well-known "Dictionary," and the abridged edition ("The Commercial Products of India"), they are not designed on lines directly helpful to business men, and necessarily omit many details which the foreign trader wants to know. In the case of every important article of Indian export Mr. Cotton has sought to specify the areas in which it is obtainable, the ports from which it is shipped, and the unit of sale and shipment. He deals with the leading ports, including the trading facilities afforded by each, and with the activities of the chief commercial organisations, chambers of commerce, etc. He also gives a conspectus of the different kinds of weights and measures, copies of tonnage schedules, an indispensable glossary of vernacular terms, and a general map of the Peninsula. Every one will share the hope expressed by Mr. Cotton that the ample material he presents to the reader, inadequately described by him as a "bird's eye view" of India's foreign trade, will enable all who are anxious to purchase her manufactures and raw materials to "make larger use of the opportunities which undoubtedly exist for increased trade."

GENERAL NOTES.

CONCRETE TANK REPAIRING.—The *Canadian Engineer* describes a novel process which was successfully employed in repairing two defective sub-surface tanks. The tanks, which were built into the ground, measured 20 ft. in length by 10 ft. in width and 18 ft. in depth. The walls and floors were of reinforced concrete, and were 10 in. thick at the top. The tanks were filled with water, and the surface all round the walls for a width of about 1 ft. was covered with bran. Bran floats for some time in water until it takes a gluish form, when it starts to sink, but very slowly. The sticky substance was naturally drawn towards the holes in the tanks, into which it was forced by the pressure of water. The operation was repeated until the tanks were made absolutely water-tight. The repair was carried out in November, 1919, since when the tanks have not leaked at all.

WHALE OIL PRODUCTION IN NORWAY.—The Norwegian Whalers' Association at Sandefjord reports that the total production of whale oil in Norway during 1919 was 23,654 metric tons. This, writes the United States Trade Commissioner at Copenhagen, is considerably less than the normal output, due partly to the fact that fewer companies were actively engaged in whaling operations, and partly to a number of whaling boats being used in carrying cargo in 1919. During the whole period of the war this industry was seriously handicapped. The amount of whale oil produced by the Norwegian whalers during the years 1908 to 1919, inclusive, is shown below:—

Year.	Metric tons.	Year.	Metric tons.
1908	11,500	1914	95,830
1909	21,500	1915	79,160
1910	30,500	1916	61,170
1911	57,330	1917	38,500
1912	80,000	1918	21,330
1913	100,000	1919	23,654

MOTOR TRADE IN JAVA.—Figures regarding the imports of motor cars and motor trucks into Java during the first five months of this year are quoted in the *Bulletin* of the Federation of British Industries. As was to be expected, America holds a predominant position in regard to this trade. The number of motor cars imported from that country during the period mentioned amounted to 1,075, as compared with 244 from Canada and only 13 from the United Kingdom, while in the case of motor trucks, 377 were imported from America as against 37 from Canada and 22 from Holland. Apparently not a single motor truck was imported during this period from the United Kingdom. As regards motor tyres, Japan heads the list with 19,761, the figures in regard to other countries being as follows:—

America	18,854
France	6,407
United Kingdom	4,971

VITAL STATISTICS OF ENGLAND AND WALES.—The excess of births over deaths in England and Wales in 1920 has up to the present been about three times the average for the corresponding periods of 1917, 1918, and 1919. For the quarter ending in June the births were nearly 100,000 more than a year ago; births totalled 248,665, and deaths 119,283. There is a net increase during the quarter of 160,067 in population, or at the rate of well over half-a-million a year. In view of this rapid increase the steadily growing urgency of the housing problem needs no emphasis. The situation is now probably at its worst, for the few houses that have been built since 1918 are but a drop in the ocean in comparison with the demand.

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PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

AIRCRAFT PHOTOGRAPHY IN WAR AND PEACE.

By Captain H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S.

Late Royal Air Force.

Lecture I.—Delivered January 19th, 1920.

THE TAKING AND PRODUCTION OF AEROPLANE PHOTOGRAPHS.

INTRODUCTION.

Aerial photography may be said to date back to the year 1858, when Paris was photographed from a balloon, and though the important developments of the science, as I prefer to call it, during the war had but little connection with pre-war photography from free or captive balloons, we are bound to regard such enthusiastic aeronauts as the Rev. J. M. Bacon, as among the earliest aerial photographers. For it was in the course of balloon photography that the great effect on the ordinary sensitive plate of ground haze, almost transparent to the eye, was noticed, and the advantages of orthochromatic plates and filters were demonstrated. On the other hand, balloon photographs suggested to Laussedat the possibility of surveying and map making by aerial photography, and constituted the medium by which the first aerial surveys were made. But when regarded from the point of view of a camera platform, the aeroplane differed considerably from the balloon, and consequently the apparatus and methods employed diverged rapidly from those of the older aeronauts.

It is sometimes stated that aeroplane photography is entirely a product of the war, but photographs had been taken from aeroplanes before 1914.* It was, however, not generally recognised that the aerial camera was destined to become such an important factor in military operations. And while the possibility of using it for military surveys was contemplated, its advantages as a source of information were scarcely considered.

The earliest work was done before and during the early days of the war, with apparatus and methods which differed little from those of photographers on the ground; but very soon improvements were commenced in every direction. In each of the belligerent countries which had aerial forces, an almost independent development of both materials and methods took place. In material the aeroplane camera underwent a continual process of evolution up to the time of the Armistice, in the course of which every part was affected. Important improvements were made in the plates and filters employed, while the methods of mounting the camera in the aeroplane were concurrently developed. At the same time, the methods of taking aeroplane photographs, and of employing them when secured, were being improved, and for some time the British Army was getting better value from the work done with apparatus which was inferior to that employed by the Germans, on account of the superiority of their methods.

At the end of 1918 aerial photography had become one of the most important sources, if not the premier source of military information; it was carried out by a large *personnel* with highly specialised apparatus. But it must not be forgotten that it is still young though it has been so rapidly developed, and while its applications in war are now well understood its future, as applied to civil purposes in times of peace, is not yet clear. In all probability we shall find that a further process of evolution in methods and apparatus will steadily proceed, and that the aerial camera will become an important adjunct of modern civilisation.

In dealing with the apparatus of aeroplane photography, I do not propose to attempt

* See illustration facing page 188 in "Photography of To-day," by H. Chapman Jones, published in 1913, for an example of pre-war work.

either a description of the modern aeroplane camera or a sketch of its evolution, for which an extensive series of illustrations would be required,* but there are certain features in connection with camera and its employment to which attention may be directed.

Apparatus.

Lenses.—Some misconception has arisen with regard to the lenses used during the war for aerial photography. The lens is, of course, the most important part of the camera, and it is a compound structure containing constituents which are manufactured from different kinds of glass. The essential features of a lens for aerial work are great rapidity, which involves a large aperture or effective lens diameter, and absolute freedom from aberrations. When compared with the lenses used in ground-cameras, those used in the air are generally of long focal length, giving greater magnification with a smaller field of view.

Now, at the outset of the war the supply of suitable lenses available in England was small, though in many cases their quality was excellent. [Some of the best air photos I have ever seen were taken with a pre-war type of lens made by Messrs. Ross and Co., Ltd.] And when we began to require more and more lenses of a type which had not been previously in demand, the British optical firms found themselves in difficulties. It was not so much in the matter of designing and constructing good lenses, but of obtaining the necessary glass which was only manufactured abroad. For a time the R.A.F. was less favourably situated as to the supply of long-focus lenses than either the German or French Air Services, but when the required glass was obtained the British optical firms were in no way behind those of the Continent. The lens-testing section of the R.A.F. photographic service, showed quite conclusively that the lenses with which we were provided were of the highest quality possible, and the oft-repeated generalisation that our lenses were inferior to those of the Germans is quite erroneous. The design and construction of a first-class lens are not simple matters, and should not normally be rushed. British aerial photographs owed much to Messrs. Taylor, Taylor and Hobson, Ltd., and to Messrs. Ross and Co., Ltd., as well as to other firms, for their strenuous and successful efforts to provide the lenses required.

The focal lengths of the lenses used in aerial cameras vary considerably, and the design and construction of the camera, its mounting and method of employment, are generally dependent on the magnification of the lens. The ground to be photographed is always at what is practically an infinite distance from the camera, and consequently the lens is always fixed at the equivalent focal distance from the plate. The scale or magnification of the picture or conversely, the area of ground depicted, can then be calculated by the simple relation. If the plate is parallel to the ground, and at a distance H from it, and if X is the distance between two points on the ground, x the distance between the same two points in the photograph, and F the equivalent focal length of the lens, then

$$\frac{x}{X} = \frac{F}{H}.$$

From this relation it will be obvious that the scale of the photograph increases with F when H is constant, or decreases with H when F is constant. Thus, if photography is done from a great height it will be useful to use a long focal-length lens, or if we wish to cover a large area of ground from a smaller altitude a shorter focal length will be desirable. The choice of a lens is then governed mainly by the type of picture required, and by the minimum height from which it can be taken. In war high flying is usually much safer, and if detail of enemy works, etc., is required, long focus lenses must be used. For topographical survey work over flat country, where small scale pictures of large areas are desired, short focal lengths may be employed In peace times, where lower flying is possible, a medium focus lens will be most useful. The most generally used lenses have focal lengths of between 6 in. and 30 in., though lenses of focal lengths as low as 4 in., and as high as about 60 in., have been employed.

The long focal length lens necessitates, of course, a very long camera, it also results in the portrayal of a comparatively small area of ground, and leads to the employment of the largest possible plate. At the same time it tends to increase the magnitude of focal-plane shutter distortion. On the other hand, the short focal length with a wide angle of view produces noticeable edge distortion in the case of pictures of country which is not absolutely flat.

Plate Size.—The sizes of plates generally employed in aeroplane cameras have been as follows: 5 in. by 4 in. (approx.), 6½ in. by 8½ in., 18 cms. by 13 cms., and 18 cms. by 24 cms. The Germans adhered for the most part to the 18 cm. by 13 cm. size. The English and French

* This work has been attempted by Ives in his book on "Airplane Photography."

Services used the smaller sizes at first, but tended more and more to employ the larger sizes later, especially with long focus cameras.

It is not correct to infer from this that the larger sizes are the best, though they depict a larger area of the ground on each photograph, and consequently tend to reduce the labour of taking, developing, and printing. But they necessitate large and heavy cameras, with heavy magazines, difficult to manipulate in the air, they entail greater possibilities of plate breakage, and probably reduce the linear area which can be photographed though increasing the lateral area. In my opinion, the smaller plates are much the more suitable for survey work, and for aerial photography in times of peace, or when a machine is operating at a considerable distance from its aerodrome. During the war the tendency on the Western front was strongly towards the use of large plates, while on the Eastern fronts the smaller plates retained undisputed superiority.

Shutters.—The great majority of aerial cameras are fitted with focal-plane shutters, which differ considerably in design, more especially as regards the methods of regulating the size of the slit or shutter opening. Some German shutters are of interest because they possess slits with curved sides, so that the width of the opening is greater at the margins of the plate than in the centre. This arrangement may be of value in equalising the exposure given to the plate, because with many lenses the image produced at the centre of the field is brighter than that formed by the marginal rays. In the *Ica* cameras of 1916 the shutter blind was of considerable length, possessing along its course several non-variable slits of different widths; for each exposure that portion of the blind containing the slit of appropriate width was used. Unless the shutter slit is self-closing, an additional safety shutter must be used to protect the plate while the blind is being rewound, and, therefore, a strong tendency has been seen in shutter design towards the slit, which is closed automatically at the end of the exposure and only opened again when the shutter is fully rewound.

It may appear at first sight that the exposure given to the plate in a rapidly moving aeroplane must be very short, or an unsharp picture will be produced; but if t = the exposure time, A = the distance of the ground, F = the focal length of the lens, v = the velocity of the aeroplane, and if d = the maximum space occupied on the plate by a sharp image of a point on the ground (say about $\frac{1}{200}$ in.), then

$$t = \frac{d \times A}{F \times v}.$$

Thus if F is small, say 6 in., and A is large, say 10,000 ft., a sharp picture may be produced from a machine moving at, say, ninety miles per hour, with a comparatively long exposure ($\frac{1}{16}$ sec.). On the other hand, there is great danger of the picture being unsharp, owing to small rotational movements of the camera; but with an efficient mode of mounting the camera there is the possibility of giving longer exposures than might be supposed. If such should prove to be the case, it reopens the possibility of using a sector or other shutter placed in immediate proximity to the lens, should this be of sufficiently small diameter not to introduce mechanical difficulties in the shutter construction.

Objections may be raised to the use of the focal plane shutter on the grounds that it introduces a small amount of distortion into the picture, owing to the travel of the aeroplane during the period when the slit is moving across the plate. The slit may take as much as $\frac{1}{10}$ sec. to traverse the plate, and during this time the aeroplane has moved forward several feet, and consequently, the position of an object near the forward edge of the picture may appear to be farther away from a second object near the rear edge of the view than it should actually be according to optical theory.

Let t = the time of travel of the shutter slit, and V = the velocity of the machine, then the camera moves forward a distance of Vt, while the exposure is being made, and the apparent shift of an object with reference to another point shown at the other end of the plate will be $\frac{Vt \times F}{A}$. With the focal length of 6 in., altitude of 10,000 ft., velocity of 90 m.p.h., and $t = \frac{1}{10}$ sec., an apparent error of ·008 in. may be produced, which is not considerable, and can only become appreciable if carried on through a series of ten or more prints. But if the values of V and F are increased, and if A is kept the same, then the focal plane shutter distortion may have to be allowed for, unless the shutter is so constructed that it moves in opposite directions in successive exposures (*e.g.*, Reihenbild Camera, Mk. IV.). It is well that this shutter effect should be clearly recognised, since it is often urged as an objection to the use of aerial photographs for survey work, and it affords an additional reason for the use of short focus lenses and generous overlaps in this type of enterprise.

Plate Changing.—It was found at an early period that the serial method of taking aeroplane photographs is the best, and this involves the use of an efficient and rapid method of changing the plates. It is not possible to describe here the very large number of mechanical devices which have been used, and the means by which the process has been rendered automatic. With well-constructed apparatus the use of magazines containing plates, controlled by gravity, has proved to be quite satisfactory in the large majority of cases. Whatever the method employed, it is necessary for some types of work, *e.g.*, road reconnaissance, to take a long succession of, say, one hundred photographs at fairly short intervals, without making any break in the series, and the English system of magazines containing eighteen plates, provided an effective means of doing this. It is generally easier to change small plates than large ones, and this may be adduced as an additional argument for plates of the smaller sizes.

Plates and Filters.—The principal considerations affecting the choice of a sensitive plate for aerial use, are :—(1) Colour sensitiveness, permitting effective screening to obviate haze effects ; (2) sufficient rapidity, depending on the light value of the locality and season ; (3) fineness of grain ; (4) good rendering of contrast. Other factors may come in, in war work, especially those concerned with development and freedom from fog. A hard emulsion is also essential to work in hot climates.

The effect of using a suitable filter for absorbing ultra-violet and highly actinic rays of short wave length, may be easily demonstrated by taking oblique photographs with and without the use of a filter. The light haze which is easily penetrated, and almost imperceptible to the eye, apparently scatters and reflects a good deal of ultra-violet light, which has a marked effect on the sensitive emulsion, and without a filter the ground detail is soon lost in mist or haze. This at some localities and periods is very noticeable, and is probably seldom completely absent ; a light yellow screen has a very beneficial effect, and is the type which has been most generally used. The employment of orthochromatic plates is consequently necessary, and the time of exposure has to be increased by an appropriate amount. The German air service was apparently content with plates which were sensitive to light of wave-lengths up to those corresponding to yellow light, but we found that still better results were obtained with plates which were panchromatic, and sensitive not only to yellow but also to red light. Panchromatic plates are produced by the use of dye sensitising substances, and one of the very important achievements of British chemists during the war was the synthesis and production of new and very efficient dye sensitisers for this purpose. The work of Professor Sir W. J. Pope, F.R.S., resulted in the production of a plate which was highly sensitive to red and yellow light, and which was manufactured by the Ilford Company, with excellent results. A greenish yellow filter is used with this plate, which gives very good colour rendering of the green and brown colours generally reflected by the earth and by vegetation.

Plates and Films.—Glass plates are heavy, liable to breakage, and require a complex changing and magazine system. Sensitive emulsion spread on a celluloid base, or negative film has the advantage of lightness and simplicity in changing, and from these important aspects it seems a suitable sensitive material to use in aerial cameras. The earliest film camera seems to have been a French one, designed by Commandant Douhet, but it did not prove very satisfactory. A somewhat similar semi-automatic camera was designed in England and manufactured by Messrs. Williamson and Co., which did some exceedingly useful work on the Eastern fronts. It had, however, certain defects, partly mechanical and partly in the difficulty of getting the film to lie perfectly flat during exposure.

For a time film cameras were dropped, but towards the end of the war a very striking and apparently efficient film camera came into use with the German air service (Reihenbild Kamera), and other English, French, and American models were produced.

The main drawbacks to the use of films are :—(1) The difficulty of getting the film to lie absolutely flat during exposure ; (2) the fact that it seems impossible to sensitise film to red light ; (3) the liability of the film to collect static electric charges during its passage through the camera ; (4) the difficulty of developing, washing, and drying, which necessitates heavy and bulky apparatus and large dust-free dark rooms. Most of these difficulties except (2) and (4), have now been overcome, and it is quite possible that film cameras will at some time in the future largely replace plate cameras. The German Reihenbild camera was interesting, because it took a large number of broad and short overlapping pictures, each

measuring 18 cms. by 15 cms.; these showed little or no distortion, owing to fore and aft tilt, and when mounted together gave a complete picture of a broad band of country; they could be well used for topographical purposes.

Camera Mounting.—In the earlier days the camera was held in the hands of the observer, but very soon it was fixed on the aeroplane. A rigid fitting was found to give rise to unsharp photographs, owing to the prevalence of short period vibrations set up by the engine. With the object of damping these vibrations, various contrivances were used to support the camera, such as stretched rubber shock-absorber, tennis-balls, or rubber sponge. The final method was to translate all the rotational movements into translational movement, which can be accomplished by the use of bell-cranks and springs.

In considering the fitting of the camera into the aeroplane, we should, however, not only consider the question of vibrational movements on the camera, but also the exact position of the optical axis and plate when the machine is flying in the air. It adds greatly to the value of an aeroplane photograph, if it can be used for estimating distances and sizes, and for this purpose the scale of the print must either be uniform in all parts, or vary according to a known relation. To secure this the camera must be maintained with the optical axis within a degree or two of the vertical, or with the axis of the pencil of incident rays arriving at a known angle to the vertical. When vertical photos are being taken, it is necessary to fix the camera with its plate in a horizontal position. This may be done on the ground, so long as the exact flying position of the machine is known; but since the flying position varies with its air-speed, one can never be quite certain as to the correct position for the camera. It is preferable, therefore, especially in the case of survey work, to make the position of the camera adjustable, and to regulate it when in the air at the correct height and speed for the work. It has been shown that when a machine is flying steadily, it is possible to effect sufficiently accurate adjustments, by reference to a spirit level, and consequently an arrangement of pivoted supports and adjusting screws can be used with a level or levels fixed to the camera.

The ideal camera mounting would, therefore, possess a good means of absorbing or neutralising vibration, a means of adjusting the position of the optical axis of the camera, and, in addition, in the case of cameras constructed on the English system, a rotational device or turret, enabling the camera to be turned round in its fitting, would also be very useful.

Oblique Photography is carried out for the purpose of obtaining a view of the ground to one side of the machine, and not directly below it. Such a view gives a kind of panorama of a wide area of country, and it is often convenient to include the horizon in the view. Early oblique photographs were usually taken with the camera held in the hand, but this is not a good method. The camera must either be fixed in the machine, with its optical axis pointing obliquely, or the camera may be fixed vertically, and the rays which enter the lens deflected by use of a mirror or prism by an appropriate amount. The most satisfactory oblique views taken on the Palestine front were obtained by the aid of a reflecting prism, which deflected the rays entering the lens by about 86 degrees. The ordinary camera can be used with very little alteration, except the addition of the prism below the lens, and the relation of the optical axis of the cone of rays to the vertical can be fairly easily ascertained. The only drawback to this arrangement is the loss of light at the reflecting surface, and the possibility of internal reflections.

Experience shows that oblique photographs, taken over country which is not well known, or mapped on a large scale, may be quite useless, owing to the great difficulty in subsequently identifying points or localities on them, for the scale of the view varies according to an unknown perspective relation, and there is no criterion by which to judge the relative distances between the objects depicted. If, however, the angle of tilt of the optical axis is known, together with the distance from the ground of the machine, and the focal length of the lens, the perspective of the view can be calculated with ease. A system has been worked out, in which the spacial relations of a view taken at a certain angle, with a lens of a known focal length, can be expressed in the form of a grid, showing the perspective of imaginary lines drawn at equal intervals apart on the ground. The spaces between these lines would represent different distances on the ground, according to the height of the machine, and provide a convenient and rapid method of making approximate calculations of the distances between objects shown on oblique photographs. This system, however, like many others, is at present only applicable in the case of fairly flat or uniform country.

EXAMINATIONS.

"DAILY SKETCH" PRIZES.

As was mentioned in the Report on the Examinations, 1920, in the last issue of the *Journal*, the Proprietors of the *Daily Sketch*, in order to encourage the study of Typewriting and Shorthand, and to assist in ensuring the supply of efficient and educated shorthand typists, offered a sum of £1,000 in prizes in connection with the Society's Examinations. In the Advanced Stage the prizes amounted to £675, the first prize being £250; in the Intermediate Stage the prizes amounted to £250, the first prize being £60; and in the Elementary Stage the prizes amounted to £75, the first being £10. The total number of candidates was 1,141, divided as follows:—

In Stage III. . .	192 candidates.
,, Stage II. . .	389 ,,
,, Stage I. . . .	560 ,,

In the Elementary Stage the prizes were awarded on the result of the usual March and May examinations without any further test. In the Advanced and Intermediate examinations a number of candidates were selected to compete for the prizes. The final test was held on September 25th, when 25 selected candidates presented themselves, 12 in Stage III., and 13 in Stage II.

The list of Prize Winners is as follows:—

LIST OF PRIZE WINNERS IN STAGE III. (ADVANCED).

	Name.	School.	Prize.
1.	Herbert C. Cock	Pitman's School, London	£250
2.	Asher Simons	,, ,,	£100
3.	Kate A. Stevens	,, ,,	£75
4.	Doris J. C. Clark	McAdam's Institution, Edinburgh	£50
5.	Olive Igle	Cusack's College, London	£40
6.	Laura E. B. Feil	Clapham Business Training College	£30
7.	Florence D. Hall	Pitman's School, London	£20
8.	William G. F. Blois	Cusack's College, London	£10
9.	Constance H. Harrison	,, ,,	£10
10.	Gladys Donnison	De Bear School, Swansea	£10
11.	Frances I. Pittendrigh	Cusack's College, London	£10
12.	Annette P. Mooney	Private Study	£10
13.	Christina M. MacDermot	Technical School, Drogheda	£10
14.	Kate Greenburg	Pitman's School, London	£10
15.	Phyllis L. Watts	Evening Continuation Classes, Worthing	£5
16.	Annie Butler	Municipal High School of Commerce, Manchester	£5
17.	Elsie N. Adam	McAdam's Institution, Edinburgh	£5
18.	Joanna Graham	Remington College, Glasgow	£5
19.	Evelyn M. Aitchison	Towne's Commercial School, Sunderland	£5
20.	Dorothy A. Dimmick	Pitman's School, London	£5
21.	Winifred R. Hearn	Private Study	£5
22.	Lily Rutter	Lower Bebington Evening School, Port Sunlight	£5

LIST OF PRIZE WINNERS IN STAGE II. (INTERMEDIATE).

	Name.	School.	Prize
1.	Arthur J. Lee	Municipal Evening School of Commerce, Manchester	£60
2.	Dorothy J. Allan	Cusack's College, London	£40
3.	Ivy Lee	Technical College, East Ham	£30
4.	Winifred Noot	Technical College, Swansea, and Private Study	£15
5.	Elsie Taylor	Cusack's College, London	£15
6.	Helen C. Leitch	De Bear School, Edinburgh	£15
7.	Marjorie Carr	Ainslie's School, 25, Regent Street, S.W. 1	£5
8.	Gladys M. Leete	De Bear School, Brighton	£5
9.	Mary Johnston	Belfast Shorthand Institute, Belfast	£5
10.	Isabel Seelig	Acton and Chiswick Polytechnic	£5
11.	Gladys M. Cumpstey	Grosvenor Museum, Chester, and Private Study	£5
12.	Anne Fowler	Cusack's College, London	£5
13.	Dinah Beagelman	L.C.C. Hammersmith Commercial Institute	£5
14.	Elsie E. Holder	Private Study	£3
15.	Maude M. Johnson	Pitman's School, London	£3
16.	Gertrude Simpson	De Bear School, Inverness	£3
17.	Ethel M. Adams	Pitman's School, London	£3
18.	Charles Howes	Council Schools, Cadishead	£3
19.	Olive Kirby	The Misses Shafto's Training College, Bromley	£3
20.	Violet R. Cranston	Cusack's College, London	£3
21.	Jessie McIntosh	City of London College	£3
22.	Emmie Reardon	,, ,, ,,	£3
23.	Charles H. Lugmayer	L.C.C. Clapham Junction Commercial Institute	£3
24.	Margaret M. Latto	De Bear School, Inverness	£3
25.	Constance E. Harris	Private Study	£3
26.	Jessie M. McCarmick	Pitman's School, Leeds	£3

LIST OF PRIZE WINNERS IN STAGE I. (ELEMENTARY).

	Name.	School.	Prize
1.	Charles S. Wood	L.C.C. Hugh Myddelton Commercial Institute	£10
2.	Dora C. Mitchell	Cusack's College, London	£5
3.	Dorothy M. E. Horsman	Day Commercial School, Kingston-on-Thames	£5
4.	Beryl W. Braddock	Day Commercial School, Kingston-on-Thames	£5
5.	Marion Frodsham	Commercial Institute, Bolton	£5
6.	Dorothy Newitt	Evander Childs High School, New York, U.S.A.	£5
7.	Catherine E. Hawkes	Day Commercial School, Kingston-on-Thames	£5
8.	Anne C. Edwards	Cusack's College, London	£3
9.	Lilian W. Clarke	,, ,,	£3
10.	Isobel C. McCourtie	De Bear School, Dumfries	£3
11.	Phyllis Crane	Pitman's School, London	£3
12.	Audrey E. J. Werry Easterbrook	Underwood School of Commerce, Portsmouth	£3
13.	Amy L. Townsend	Cusack's College, London	£2
14.	Elsie E. Downer	De Bear School, Brighton	£2
15.	Annie S. Findlay	De Bear School, Liverpool	£2
16.	Nora Moore	De Bear School, Belfast	£2
17.	Gwendoline M. Trolove	Central Classes, Boston	£2
18.	Hulda Kossak	Private Study	£2
19.	Vera B. Schofield	Metropolitan College, Dublin	£2
20.	Emily A. Lisney	Day Commercial School, Kingston-on-Thames	£2
21.	Dorothy Tyler	Technical School, Hanley	£2
22.	Alice Stanley	De Bear School, Huddersfield	£2
23.	Mildred E. Phillips	Day Commercial School, Kingston-on-Thames	£1

Name.	School.	Prize.
24. Margaret Grainger	De Bear School	£1
25. Margaret G. Millar	De Bear School, Edinburgh	£1
26. Dorothy E. Palmer	Handsworth Technical School	£1
27. Gertrude M. Cork	Cusack's College, London	£1
28. Isabella A. Forbes	Devonport High School, Plymouth	£1
29. Annette G. Taylor	Day Commercial School, Kingston-on-Thames	£1
30. Gertrude Berrow	Day Commercial School, Kingston-on-Thames	£1
31. Gladys L. Allden	Day Commercial School, Kingston-on-Thames	£1
32. Gwendolen Hart	De Bear School, Manchester	£1

POST-WAR INDUSTRIAL DEVELOPMENTS.*

By R. E. Graves, C.B.E.,
H.M. Chief Inspector of Factories.

The first year after the cessation of hostilities has been a very notable one for industry, and it is remarkable how complete has been the change over from war to civil production, and with what wonderful smoothness this stupendous task has been accomplished on the whole. The first great step in the transformation was the gradual, and now almost complete, withdrawal of women from the men's industries where they performed such magnificent service during the war, and the absorption into industry of the demobilised men. The next great step was the resumption of the manufacture of the ordinary articles of commerce. In many trades the manufacturers had little difficulty because the articles made were much the same either for war or peace purposes, but in many others which had been equipped specially for the manufacture of war material, new work had to be found and machinery and plant adapted. For example, factories in which aeroplanes were made are now being used for the manufacture of furniture, motor vehicles, wooden toys, etc.; a cartridge case factory is now making household hollow ware; shell-factories are making such things as steam-boilers, locomotives, agricultural tractors, and milk churns; and at a factory where concrete ships were built concrete blocks for house building are now being turned out. One very large armament firm have turned their attention to the making of railway locomotives, marine engines, and boilers.

Without exception the reports refer to the unprecedented demand for commodities of all sorts, and apparently manufacturers generally have booked enough orders to keep them fully occupied for a long time to come. To meet this great pressure they have been reaching out in all directions with a view to expansion, and the demand for buildings and plant of all sorts is only equalled by the general unsatisfied demand for everything. All the reports refer to difficulties in the way of progress, but the following from Mr. Walmsley (Midland Division) is typical as to the position:—

"Many factors have combined to retard progress, amongst which may be mentioned difficulties and delays in transport, reduced hours of labour, labour disputes, and the shortage of raw materials and fuel, whilst the steady and continued increase in prices has made it extremely difficult for manufacturers to enter into contracts of any magnitude. Notwithstanding all these adverse influences and the unprecedented high prices of goods generally, the demand for practically every marketable commodity has probably never been so great. Even in such luxury trades as jewellery, silver and electro plate, the manufacturers have had their stocks completely cleared out."

The shortage of houses and of skilled labour are mentioned by other inspectors as additional hampering factors. . . .

In order to meet the ever increasing cost of production and the scarcity of labour, and to speed up production, there appears to have been, all over the country, a very general conversion of workshops into factories by the introduction of mechanical power. Several of the reports refer to the greatly extended use of electrical power, both for this purpose and also for motive power in large works. Mr. Rogers mentions that in Bristol the supply of current for power has increased from 11,000,000 units in 1914 to 21,000,000 in 1919, and Mr. Wright reports that in the Newcastle-on-Tyne district extensions have had to be made in the public supply generating stations to cope with the increased demand for power, and also refers to the installation in one large iron mill of electrical plant for driving a large reversing rolling mill requiring 2,500 to 8,500 h.p. Mr. Wilson (Northern Division) says its use is on the increase for heating metal furnaces and for welding steel castings.

The following are trades in which developments are specially mentioned:—

Shipbuilding and repairing (S.E., S.W., N.E. and Northern Divisions).—There has been conspicuous growth of the industry on the East Coast of Scotland at Alloa, Burntisland, Kinghorn and Dundee, and an important development at Londonderry, where several thousands of men are now employed in the industry. In the Newcastle district, however, while orders are plentiful and yard space is being increased, there has been a decline in output on the Tyne and the Wear as compared with the years just before the war. This is attributed to several causes (1) the strike in the early part of the year, (2) the shortening of hours to 47 per week, (3) the stoppage of work on Admiralty ships, (4) inadequate railway transport, (5) a natural slackening of effort on the part of the workmen after five years of strenuous war work.

Glass (S.E., Midland and N.E. Divisions).—This industry was developed enormously during the war, particularly in the manufacture of such articles as optical and chemical glass ware and

* Extracted from "Annual Report of the Chief Inspector of Factories and Workshops for the Year 1919." Cmd. 941. 1s. 6d. net.

electric lamp bulbs, which were almost entirely made in foreign countries before the war, and in other branches of the industry, such as the manufacture of bottles of all sorts, and domestic glass ware, further developments are now taking place. One firm in the Midland division who made a very large proportion of the aeroplane gunsights required during the war is now developing the manufacture of lenses for cameras and scientific instruments. In the manufacture of bottles there has been a wide movement towards amalgamation, and several large works have been erected. Mr. Jackson (N.W. Division) refers to "a very marked revival and extension," while Mr. Wright (N.E. Division) says "the installation of automatic machinery promises shortly to revolutionise certain branches of the industry." Mr. Walmsley (Midland Division), while mentioning developments in various directions, says, "Very little progress has, however, been made in improved methods of manufacture, and it is doubtful if under existing conditions of production the trade could successfully hold its own against foreign competition."

The *Hosiery* trade is very brisk, and the starting of new works is mentioned in Derbyshire and also in Scotland and Ireland. With regard to Scotland Mr. Wilson says that employers have been wise in establishing their new premises in districts where employment for females was needed.

In the *growing and de-seeding of flax* in S.W. England there have been interesting developments, due largely to organisation by the Board of Agriculture and Fisheries. In 1914, only a few hundred acres were under flax, and only one scutching mill was known. In 1919, over 3,400 acres were grown and seven or eight scutching and de-seeding factories were at work.

Other trades in which developments are in progress are motor vehicles of all sorts and general engineering in several districts; synthetic dyes and fine chemicals, including increased output of phenacitin, aspirin, and saccharine (N.E. Division), while in the N.W. Division the position of the dyers and calico printers, who were hard hit for want of dyes during the war, has been relieved, to an extent which could not have been anticipated, by the enterprise of firms in our rejuvenated dye-making industry. In the Midland Division a large number of brass articles which were formerly cast are now being made by hot stamping and pressing, and machine moulding of brass is making some headway. A steadily growing trade in the manufacture of magnetos, formerly obtained entirely from Germany, is also reported, and two trades, namely the hearth furniture (kerbs, coal boxes, etc.) trade, and the perambulator trade, are mentioned as giving employment to many disabled soldiers. One firm of perambulator makers has had over 85 per cent. of their work done by one-armed men.

Both the Midland and N.E. Divisional reports refer to amalgamations and co-operative arrangements between firms with a view to increased and cheapened production. Standardisation and specialisation appear to be the order of the day. In this connection Mr. Walmsley specially mentions the stove and range manufacturers and the gun trade. In the latter the movement has been carried very far, a Limited Liability Company having been formed of all the registered members of the trade, "the scheme being designed to benefit all those engaged in the trade by transferring certain processes from factories which are not so well equipped as others, and assigning such work to firms who have specialised in that particular class of work. This Company . . . will interest itself mainly in output and reduction of costs, thus enabling its members successfully to meet foreign competition. A committee of experts has been formed to decide upon patterns and to draw up specifications for various parts." Mr. Law (Sheffield) also mentions the development of mass production in some of the lighter steel trades, and the adoption of labour-saving machinery in the cutlery trade, particularly in the forging of table blades, and the stamping and grinding of scissors and razors.

Mr. Wright (N.E. Division) reports the following interesting developments in industrial research.

The British Research Association for the Woollen and Worsted Industry, having a membership of some 450 firms, was established early in 1919 in connection with the Department of Scientific and Industrial Research. It has already carried out a large amount of useful work at Leeds University and kindred institutions, and it is now about to remove to premises near Bradford where chemical and physical laboratories will be established together with engineering and other workshops. Its aim is to benefit the industry as a whole rather than individual members.

The Glass Research Association with headquarters at Sheffield has come into being more recently. Dr. W. E. S. Turner, head of the Glass Department at Sheffield University, writing recently on the future prospects of the British glass industry, expressed the view that there are three hopeful signs of success: (1) the increased capital now flowing into the industry, (2) the greater interest being taken by British manufactures in the methods employed in the United States, where engineering has been brought into the industry with results of an astonishing character, and (3) the formation of the Glass Research Association. He also mentions indications that manufacturers are beginning to see the need for employing technical skill in the works for the benefit of the firm itself, and that during the last session they have had at the university a large entry of students intending to take either the Diploma or Degree course in Glass Technology.

MESOPOTAMIA.

A report upon the conditions of trade in Mesopotamia during last year has been prepared in the Civil Commissioner's Office at Baghdad, and is quoted in the *Board of Trade Journal* of September 30th.

The great alluvial plain of Mesopotamia, with its 120,000 square miles of area, and its scattered population numbering now some 2,800,000, had before the war no properly equipped seaport, and few means of internal communication except by the rivers Tigris and Euphrates. Even river navigation, especially of the Euphrates, was greatly restricted by narrows and shallows. Ocean steamers which passed from the Persian Gulf up the Shatt-el-Arab depended entirely on their own gear and on native river craft for the landing and shipping of cargo. Now there are at Basra adequate wharves, capable of accommodating deep steamers, fitted up with cranes and laid out with railway sidings. The Port was constructed in order that military operations might be carried on effectively, and now remains for the purpose of commerce. There are 875 miles of railway lines (chiefly of metre gauge). Shargat towards the north, the Persian frontier to the east, and Basra in the south are all now connected with Baghdad by rail. Roads have been improved until many of them can carry light motor traffic, and some few will bear motor lorries. So far, at least, as communications are concerned, the war has wrought a very great and beneficial change in Mesopotamia.

During the last two years there has been a marked increase in the imports into Mesopotamia. In 1919 the goods coming through Basra were valued at 1,399 lakhs of rupees (100,000) against 1,110 lakhs in 1918, and 398 lakhs in 1912. The total import trade for 1919, including land imports into Baghdad, was valued at 1,840 lakhs. The increased importation of foreign goods into the country has been due partly to the presence of troops and the depletion of stocks under war conditions, and largely to the almost complete cessation of imports into Persia via the Caucasus. It is estimated that from one-half to three-quarters of the goods imported by sea eventually find their way into Persia, and it cannot therefore be emphasised too much that the trade of Mesopotamia is closely allied with that of Persia, or with that portion of Persia which can be reached easily by way of Baghdad. Those who seek to supply goods to Mesopotamia should therefore pay as much attention to Persian requirements as to those of the local population.

The values, in lakhs of rupees, of the principal imports during last year were as given below. India during the war gained a firm hold on the market for cotton piece-goods.

	Baghdad.	Basra.	Total.
Textiles	253	704	957
Sugar	22	196	218
Tea	5	60	65
Grain, pulse, and flour	2	63	65
Tobacco	18	46	64
Carpets	42	—	42
Liquors	4	25	29
Cigarette papers and smokers' requisites	3	23	26
Metals and ores	6	19	25
Soap	7	16	23

The values, in lakhs of rupees, of the principal exports during 1919 were:—

	Basra.	Baghdad.	Total.
Dates	217	4	221
Piece-goods	37	494	531
Grain	27	2	29
Wool	15	10	25
Carpets	9	27	36
Sugar	3	77	80
Tea	2	32	34
Spices	½	9	9½
Gum	2	8	10

The annual export of dates may be estimated at about 50,000 tons in cases and 30,000 tons in baskets, etc. Of the 1919 shipments the United Kingdom took 42 per cent., India 28 per cent., and Arabia 9 per cent.

Piece-goods to the value of 529 lakhs of rupees, and almost all the sugar and tea exported in 1919 were destined for Persia.

Wool exports were only 15,150 bales in 1919 as against 27,500 bales in 1918. In 1916 and 1917 there were 13,063 bales and 16,343 bales respectively as compared with 43,290 bales in 1912. The reduction in exports during and since the war is probably temporary, and due to the reduction in the flocks caused by the military demands for mutton.

Barley and dates form the bulk of the export trade in agricultural produce. The area of land under cultivation is capable of enormous extension. The methods of the Arab farmer are primitive though his skill is considerable. All agricultural implements in present use are hand made. There are openings for the simplest as well as for the most complicated agricultural machinery. The Agricultural Directorate offers facilities for trials of new machinery on its central station at Baghdad, and machines which pass the trials can be demonstrated on the five district stations. The results of the trials are awaited with great interest. Agricultural labourers trained in the use of Western machinery are now available.

Openings exist for dairying appliances, grass and wool presses, flour mills and oil mills, and also for artificial manures. Trustworthy vegetable seeds are in demand, and improved varieties of fruit trees command attention.

River conservancy and flood protection are at present more important than irrigation. The Arab will co-operate with the Irrigation Department to bring water to his land, but he is not eager to do hard work on flood banks, of which he does not appreciate the benefit. The bulk of the heavy work on flood protection has now been done, and the task of the future will be chiefly that of maintenance. The Irrigation Department is at present confining itself to small and immediately remunerative schemes.

TRADE PROSPERITY OF CHINA.

Writing in the *Times Trade Supplement* Professor Middleton Smith gives an interesting account of the present position of trade in China.

"It is worthy of some reflection," he says, "that although politically China is in a state of chaos, yet commercially the country was never so prosperous. It is being demonstrated that the real strength of the country lies in the wisdom and enterprise of the business men.

"The politicians, with their many intrigues, have failed to accomplish anything but an increased debt and occasional outbursts of civil disturbance; the business men have been hard at work and have, as the Americans say, 'made good.' Before the war ended the writer stated that only one part of the world could supply what would soon be needed in Europe; that part of the world was mentioned—it was the Far East.

"Mr. Unwin, in his admirable Trade Review for the Imperial Customs Service, tells us what actually happened. 'After a period of uncertainty and hesitation,' he writes, 'the insatiable food hunger of Europe, and the demand for raw materials made itself felt imperiously in all our markets.' That is to say, China has helped Europe since the war.

"The demand will continue. You can smash up a machine quite easily, but it often takes a very long time to repair it after it has been smashed up. The economic machine of Europe, if not exactly wrecked, is in a very different state of working from the smoothly running machine of pre-war days. But China is in an altogether different state. Out here the economic machine is being improved and perfected, and, although the politicians at times do what is equivalent to putting sand into the bearings, yet on the whole the machine works well. It is on very sure foundations. China has resources, vegetable, mineral, and human, of amazing value, and all that is needed to turn them to account is scientific knowledge and proper organisation.

"It is astonishing that there are Europeans who shake their heads about China and prophesy that the people and the country will never change. They both have changed. Commercial history in China is being made at aviation speed. There are figures which prove that the China of to-day is no longer the China of even ten years ago.

"The great demand for the food and other products of China has brought wealth to the traders, and has enriched the farmers and artisans. The silver shower has enabled Chinese merchants and others to start commercial enterprises in the country. There never was such a demand for machinery as has existed during the last few months.

"It is pathetic to think that in China great chances have been lost. The Treasury of the country is empty; in the past all sorts of promiscuous borrowings from Japanese sources enabled the Chinese Government to 'carry on' from month to month. The notes that have been issued from time to time are now worth only a fraction of their face value. Silver is demanded—the 'promise to pay' of the paper currency is regarded with suspicion. But let us be quite clear about one matter. It is only the word of the Governments — Central and Provincial — that is questioned; the splendid integrity of the vast majority of the business men of China remains unchallenged.

"It is remarkable that the trade of China should have shown such great vitality despite the almost complete failure of the Government. Moreover, other influences have been at work which might easily have reacted unfavourably on the trade returns.

"The Chinese have a remarkable word, which is pronounced *Kung*, and which conveys, to the Chinese mind, simultaneously the meanings of our English words *justice* and *publicity*. That is to say, the Chinese believe that justice and publicity go hand-in-hand. But the publicist, in these days, has a great responsibility. Nothing should be written or said that might be likely to upset further the very unstable political conditions of the world to-day. On the other hand, there are certain facts which are so well known that it is useless, perhaps even dangerous, to overlook them. And one of those facts is the Japanese boycott by the Chinese.

"Throughout last year there was, in China, an extensive boycott of Japanese goods, which, in the opinion of experienced observers, is likely to continue. The Statistical Secretary of the Chinese Maritime Customs says that it 'no doubt considerably injured Japanese trade, at the cost of heavy loss and much injustice to Chinese traders, and has served to engender and keep alive feelings of bitterness and resentment on both sides.' Nobody can defend the weapon of the commercial boycott as a lever for ensuring political ends. But the Chinese have always used it, and often with considerable success.

"The state of China's commerce is healthy. But when that great day of settlement comes which will usher in a new era of proper government, the trade of the country will increase enormously. In the past British firms have been sowing the ground. It is probable that each year the harvest of trade will increase. And that is what Britain needs. At the present time, however, there is considerable competition."

THE JAPANESE TOY INDUSTRY.

The toy industry is a comparatively recent development in Japan. Statistics of production prior to 1913 are of very little value, owing to the smallness of the trade then. The production of toys was valued at approximately £1,228,000 in 1913 and had increased to £1,679,000 by 1918. During this period the imports of toys into Japan decreased from £10,000 in 1913 to £6,000 in 1918. The imported toys consist mostly in better-grade mechanical devices, etc., which, although the initial cost is greater, last longer than the domestic article. The Japanese toy is attractive to the eye, but is likely to break or become damaged in a short while. Among the countries from which

toys were imported into Japan in 1913 Germany was first with £6,300. The United States followed with a value of £2,170. The trade with Germany ceased during the latter years of the war, but the imports from the United States increased from £2,170 in 1913 to £5,800 in 1918. This would lead one to believe that possibly there is room for a further development of this trade, especially in view of the increased wealth of Japan and the growing demand for better goods.

The toy industry in Japan is still in the household stage save for celluloid, porcelain, and metal toys of the better grades. Thus the industry is mainly a hand and not a machine trade, which prevents uniformity of product and keeps profits down to a level lower than those offered in other industries. This tends to curtail production through shortage of labour. Even in the making of "factory" toys, which has shown by far the greatest development since 1913, the number of employees is reported to have increased only from 4,692 in 1913 to 7,622 in 1917.

It appears from a report by the United States Vice-Consul at Yokohama that the principal toys made in Japan are of celluloid, porcelain, clay, rubber, metal (tin and nickel chiefly), wood, cotton, and paper. The production of wooden toys in 1918 was valued at £160,700; of porcelain toys, £166,100; celluloid, £450,500; metal, £148,700.

The centres of production are Tokyo for celluloid, metal, and rubber toys, and dolls; Osoka for celluloid, cotton and paper toys, and dolls; Kyoto for porcelain toy tea sets, other porcelain toys, dolls, paper and cotton toys; Nagoya for porcelain and clay toys, wooden toys, etc.; and Yokohama for wooden, mosaic work, and other toys of a similar nature.

The finished articles made in the homes are collected at various depots by middlemen, some of whom also export directly. Manufacturers seldom export direct, except a few of the larger ones who have capital. The industry as a whole seems to be suffering from a lack of ready money, which may account for the non-centralization in large plants, and the poor quality of the products. It is rarely that any large supply of toys of any variety is kept in stock. Toys are mostly made upon individual order from sample, and sold usually upon a thirty days' payment basis.

In addition to the toy factories, a considerable number of factories making celluloid, porcelain and metal products, also manufacture toys.

Owing again to the scattered, household state of the toy industry in the main, it is impossible to estimate accurately the cost of production. However, generally speaking, the cost is 40 to 60 per cent. of the selling price for wooden toys, 80 per cent. for celluloid toys, 60 to 80 per cent. for porcelain and clay toys, and about 60 per cent. for cotton and paper toys.

Selling prices appear to have maintained a fairly uniform level, notwithstanding the heavy blow dealt by import restrictions imposed during 1917 and 1918 by both the United States and Great Britain. Celluloid dolls were the only toys that appreciably decreased in value, the decrease from 1917 to 1918 averaging roughly about 3s. per dozen. On the other hand, mechanical toys showed an average increase in price of about 30 per cent., due probably to the greater skill of workmen employed in their manufacture.

The metal toy trade (mostly of tin and nickel) seems to be in a comparatively prosperous position. Definite statistics as to quantities and sources of metal used are lacking. However, it is probable that no great proportion of the metals imported from the United States have been diverted to the toy industry. At present, celluloid dolls ("kewpies") and other celluloid toys are going to the United States in considerable quantities.

In order to protect the future of the celluloid industry by preventing the export of inferior goods, inspection is made, and the following specific causes are made the basis of rejection of merchandise: (1) Changeable colours or of materials that are not "fixed"; (2) material too thin for the size of the article; (3) defective manufacture; (4) use of fusible or soluble paints; (5) not properly joined with elastic thongs at joints. Infringements or attempted infringements are punishable by a fine of 100 yen (£10) for each offence against the standards set for export goods. However, for those manufacturers approved and sanctioned by the Governors of the various Prefectures, these standards do not seem to be strictly applied; and it is said that, while inspection is nominally carried out for all toys, results are not very noticeable.

The Japanese manufacturer is beginning seriously to study the wants of his foreign customer. However, the margin of profit being small, there is a strong temptation to realize larger returns at the expense of future business. The results of this tendency are somewhat reflected by the fact that the total export of toys from Japan during 1919 was only £1,327,000 against £1,040,000 for the year 1918, when war restrictions were in force in some of the countries. The post-armistice period has not brought the large orders expected; and the small manufacturer, middleman and exporter are being rather hard pressed. Still, this "weeding-out" process is having the effect of improving the quality of articles produced. The industry is becoming centralised, and the future for those remaining in the business is good. Expected competition from the United States, Germany, and elsewhere will probably be met with comparative ease.

For a time porcelain doll heads constituted an important item in exports. However, inferior quality, an earlier predilection to give Mongolian features to the faces, and various other faults, reacted unfavourably. At present celluloid toys are the principal item. Out of a total export of toys from Japan of £1,040,000 in 1918, £226,500 represented the value of celluloid articles. A considerable share of this export consisted of cheap toys for the bazaar trade.

On account of the import restrictions placed on

toys during 1917 and 1918 by the United States and Great Britain, and the loss of trade from Europe—exports to Spain showing the only increase to a European country—the Japanese exporter endeavoured strongly, with considerable success, to get increased trade in China, Hongkong, British India, Dutch East Indies, Peru, Chile, Argentina, Brazil, Egypt, South Africa, Australia and New Zealand.

Generally speaking, concludes the United States Vice-Consul, the Japanese toy industry appears to have a comparatively promising outlook for the future.

PRODUCTION OF GLYCERINE FROM SUGAR.

At the beginning of the war Germany was "swimming in sugar," to use a newspaper expression. Production had been greater than ever; large quantities left from the previous years were still available; and exportation had stopped. One of the ten "war commandments," set forth on bills posted in all railway stations, advised the people: "Use plenty of sugar with your meals; sugar is an excellent food." Certain measures of the Government, however, soon made it impossible for the people to follow that advice, and sugar became scarce in the market, although it was known that stocks were plentiful, for the production of the 1913-14 crop had yielded 2,715,870 metric tons of sugar. Germany had been the leading sugar-producing country of Europe, and yet the people suffered from scarcity of sugar during the war, and were compelled to use honey and saccharin as substitutes. It was supposed that owing to the shortage of fats the Government was trying to conserve the stocks of sugar. However, according to a memorandum prepared by the Research Division of the United States Bureau of Foreign and Domestic Commerce, it now appears that large quantities of sugar which had been withdrawn from human consumption were used in the manufacture of glycerine for war purposes.

The consumption of glycerine in the manufacture of cosmetics and for other purposes, chiefly in the manufacture of explosives, increased enormously during the war, while the supply of the raw materials—fats—was constantly diminishing. It was, therefore, necessary to seek other sources, and sugar was selected, as its chemical structure is somewhat similar to that of glycerine. The transformation of sugar into glycerine was accomplished by the biochemical method. It had been known for a long time that in the ordinary fermentation of sugar with yeast small quantities of glycerine would be produced, amounting to about 3 per cent. of the sugar. By adding alkalis to the liquid in fermentation the production of glycerine was increased. It was found that almost any salt with an alkaline reaction could be used for that purpose. Experiments were made with acetate, bicarbonate, and dibasic phosphate of sodium and with carbonate of ammonia. The yield of glycerine was increased to 12·7 per cent., but the alkaline mash was found to be an excellent breeding place for all kinds of acid-forming bacteria, which would pollute the glycerine. This fault was remedied by the use of sodium sulphite, which acts as a poison to the bacteria of lactic acid and others, but does not, even in large quantities, affect the yeast cells (Saccharomyces). When sodium sulphite was employed as an antiseptic the yield of glycerine was increased proportionately to as much as 23 to 36·7 per cent. of the sugar.

The ordinary fermentation produces not only alcohol, carbonic acid, and glycerine, but also small quantities of acetaldehyde. When the sulphite is added in increasing quantities the yield of acetaldehyde and glycerine increases, while that of alcohol and carbonic acid decreases. The acetaldehyde was used largely for war purposes. The production of glycerine from sugar had a great practical value in war time, according to German writers. The manufacturing process, patented in 1915, was exploited on a large scale, and the production of glycerine exceeded 2,200,000 pounds a month. The invention also possesses an unusual theoretical interest, as it shows how the transformation of materials by bacteria can be influenced by the addition of chemicals. In the words of a German writer, "the biochemical processes open up new prospects for the future, and seem to be destined to provide many substitutes to a people robbed of all raw materials."

Attempts made during the war in Austria-Hungary to produce glycerine from sugar do not seem to have met the success claimed for similar attempts in Germany. Complaint was made by the Bohemian journals of Prague that carloads of sugar had been wasted in recovering negligible quantities of glycerine, and doubts were expressed whether such waste of food could be justified even by the exigencies of war.

OIL FROM RUBBER SEED.

An article in the "Bulletin of the Imperial Institute" (John Murray) discusses in detail the possibility of utilising the large quantity of seed now being produced on rubber plantations. In the early stages of the rubber industry in the Middle East the seeds were mostly used for raising plants for making new plantations, but as there are now at least 1,000,000 acres under rubber trees the quantity of seed available is much in excess of the planting requirements. It was shown many years ago by investigations made at the Imperial Institute that the kernels of Para rubber seeds yield a large amount of oil similar in properties to linseed oil, and that this oil can be used for paint-making and other purposes for which linseed oil is employed, whilst the cake which is left after the oil has been removed from the kernels is an excellent feeding-stuff for live-stock. Until the last year or two, the oil had only been produced on an experimental scale, but at least one oil mill is

now established in Malaya for crushing rubber seeds, and small commercial consignments of the oil have been sold recently in this country and in Marseilles at good prices. Whether it will pay the planter to supply the seeds to an oil mill depends very largely on the cost of collection, a point on which experts differ. In view of the present necessity for the exercise of rigid economy on rubber estates, and of the enormous demand for oils and feeding-stuffs, it is highly desirable that serious efforts should be made to organise the collection of Para rubber seed wherever it is likely to prove at all profitable, and so prevent waste of material which is undoubtedly of considerable value.

NOTES ON BOOKS.

WEST AFRICAN FORESTS AND FORESTRY. By A. Harold Unwin, D.Oec., late Senior Conservator of Forests, Nigeria. London: T. Fisher Unwin, Ltd. 63*s*. net.

The potential wealth of the forests of West Africa must be almost boundless. We have immense stretches of country covered with vegetation of every description, from fast-growing bamboos and soft-woods to such valuable trees as teak and mahogany. For every purpose to which timber can be put, from paper-manufacture and firewood to the finest cabinet work, West Africa provides material in extraordinary profusion. When, however, one comes to inquire into the actual present value of these forest products, one is surprised to find how small it is. For instance, the value of the forest exports of Gambia in 1914 was £658,911; of Sierra Leone, £900,846; of the Ivory Coast, £519,364; of Togo (in 1913), £175,112; of the Cameroons (in 1912), £1,166,539. The main reason, of course, is the lack of means of transport. The great proportion of the most valuable trees grow in regions that are at present quite inaccessible, and not until the country is well opened up will these great sources of wealth be brought within reach of their markets.

But even though, generally speaking, the West African forests remain untouched, in some districts they are already in considerable danger from careless treatment and neglect. Dr. Unwin quotes the case of the Gold Coast, from which in 1913 forest produce in the shape of logs, etc., to the value of £3,327,743 was exported. There seems to be a real danger here that the people of the Gold Coast may kill the goose that lays the golden eggs. There is a strong opposition to the formation of Forest Reserves, which are now generally accepted as the soundest means of securing the safety of forest areas. As Dr. Unwin remarks, "in India, European countries, Canada, Australia, and in the United States it has been proved that only by a central Government Agency that the forests will be properly preserved, both for this generation and the next; therefore, before it is too late it behoves the Gold Coast people to recognise their responsibility to future generations and allow the necessary legislation so that the forests may be preserved and rightly utilised." And, apart from the intrinsic value of the timber itself, the importance of forests as affecting the climate of a country is now very clearly recognised. The author quotes as instances of countries which are now suffering from having permitted the destruction of their forests, Spain and Portugal, Morocco and Mesopotamia, Palestine and a portion of the Soudan, which is only now being laboriously re-afforested by the Forest Department there. Dr. Unwin does well to draw attention to these important matters, for although the forest areas of West Africa are so vast, the sooner they are placed under proper control and so assured against permanent damage the better for all concerned.

The discussion of this question of forest preservation, however, is a mere incident in Dr. Unwin's volume. His main purpose is to give some account of the trees themselves and of the principal work of the Forest Department. When one considers the immense variety of the West African timbers the greatness of the undertaking will be at once appreciated. The work is divided into fourteen chapters, of which the first ten are devoted to separate regions, such as Gambia, Sierra Leone, Liberia, etc.; Chapter XI. deals with the oil beans, seeds, and nuts of the forest; Chapter XII. with the oil palm and palm kernel industry; Chapter XIII. with the forest in relation to agriculture, while Chapter XIV. contains a brief but valuable bibliography of West African forests.

Each of the first ten chapters contains some account of the district with which it deals, and this is followed by a descriptive list of the trees indigenous in that region. A great amount of labour must have been spent on the compilation of these lists; in addition to accounts of the trees themselves short notes are given of their products and of the uses to which they are put. The text is illustrated by over a hundred photographs taken by the author.

Dr. Unwin is to be congratulated on the completion of a most valuable and important volume, which he is qualified to write by thirteen years' service in West Africa in forestry work.

METEOROLOGY. By R. G. K. Lempfert, C.B.E., M.A. London: Methuen & Co., Ltd. 7*s*. 6*d*. net.

During the war meteorology, like many other branches of science, was utilised in planning naval and military operations to a far greater extent than ever before. On land, at sea, and in the air its applications have been widely increased. In a paper which he read before the Society in 1919, Sir Henry Lyons, then Acting Director of the Meteorological Office, explained in considerable detail the necessity for studying meteorological conditions, not only in connection with such matters as naval and air raids, but also in the planning of land campaigns where weather is apt to be an important, sometimes even a deciding factor. In times of peace, also, a knowledge of

the science is of great value. The power of forecasting the weather is important to the agriculturist, for example, who is in a far better position to plan out his operations if he has some idea as to what the meteorological conditions are likely to be within the next few days.

Great advances have been made in the study of this science during the last thirty, and more especially during the last six years. The atmosphere has been systematically explored by means of kites and balloons, while meteorological instruments have been enormously improved. In the present volume Mr. Lempfert describes in as simple a style as is compatible with the complexity of the subject, the main results derived from the new methods of observation. The book will be of great value to the serious student of meteorology, and even to the layman it is full of interest. In his opening chapter the author gives a striking instance of the value of weather maps. He examines in detail a number of maps, and in particular that showing the meteorological distribution on the morning of February 17th, 1915, on the evening of which day two German airships were lost through stress of weather on the coast of Denmark. Had the German authorities been in possession of fuller reports as to the weather conditions in the West, they would no doubt have recalled their ships; or possibly would not have suffered them to leave their sheds at all that day.

The book is illustrated with a number of diagrams and plates, which the reader will find of great assistance in studying the text.

GENERAL NOTES.

American and British Telephones.— Sir William Noble, Engineer-in-Chief to the British Post Office, in the course of a recent address to the members of the London Centre of the Institution of Post Office Electrical Engineers on "Telegraph and Telephone Engineering in the United States," said that while development in telegraph and telephone engineering was practically at a standstill in this country during the war, American engineers had been preparing plans to apply the most up-to-date improvements throughout their system, and to replace their exchange plant in all the large cities by the automatic system. One feature of the American organisation which impressed him most was their unique and extensive provision for research in all branches of telegraph and telephone science, and there was no doubt that America's foremost position was largely attributable to the generous policy which had been followed in that matter. The general introduction of automatic exchange working was probably the main feature in their scheme of progress. Discussing this matter with telephone experts at all the cities he visited, he found practically a unanimous opinion that full automatic working was the only certain method of ensuring the quality of service now demanded by the public. In this country there were at present three types of dials, each with a different scheme of impulses. It had now been decided that all systems supplied for use in Great Britain should, in future, be designed to operate from a dial with an average speed of ten impulses per second, the break portion of each impulse being within the limits of sixty per cent. to sixty-six per cent. of the complete impulse. This would accord with the standard adopted in America. The impression he obtained from the investigations made of the panel equipment and the facilities available were so favourable that he persuaded the American Telephone and Telegraph Company to give him the option of purchasing a 3,500 line equipment of the panel type, to enable British Post Office engineers to be in a position to get down to the details of the panel equipment simultaneously with telephone engineers in America. The Secretary to the Post Office had agreed to his proposal to instal it in London. Arrangements had now been completed to introduce it in G.P.O. South, where it would form the nucleus of a 10,000 line exchange. Mechanical tandem junction working would be as accurate, and nearly as rapid, as full automatic direct junction working. A small departmental sub-committee of the Post Office was now considering the introduction of a mechanical tandem exchange for London. Their investigations, although not yet completed, were so far favourable. The popularity of the telephone in America was, he considered, due first of all to the flat rate, secondly, to monthly accounts, and thirdly, to party line services and the policy of fostering residential lines.

Institution of Petroleum Technologists.— The opening meeting of the forthcoming session of the Institution of Petroleum Technologists will be held at the house of the Royal Society of Arts on Tuesday, October 19th, when Sir Arthur McD. Duckham, K.C.B., M.Inst.C.E., will read a paper on "Coal as a Future Source of Oil Fuel Supply." The chair will be taken at 5.30 p.m.

"Living-in" on Canal Boats.—The question of "living in" on canal boats was discussed in the paper on "English Canals and Waterways," which was read before the Society by Mr. Sidney Preston, C.I.E., C.B.E., on February 18th last (see *Journal* of March 19th, pages 279-88). The Minister of Health has appointed a Committee to inquire into the practice and report whether any alteration is desirable. The members of the Committee are: Mr. Neville Chamberlain, M.P. (Chairman), Mrs. E. Barton (Sheffield City Council and Women's Co-operative Guild), Mr. O. J. Llewellyn (Inspector under the Canal Boats Acts), Mr. T. McKerrell (Ministry of Labour), Mr. H. J. R. Murray (H.M. Inspector of Schools), Mr. Sidney Preston, C.I.E., C.B.E. (Ministry of Transport), and Dame Louise Gilbert Samuel, D.B.E. (Chelsea Borough Council). The Secretary of the Committee is Mr. Arthur Jones, of the Ministry of Health, and communications for the Committee should be addressed to him at the Ministry of Health, Whitehall, S.W. 1.

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FRIDAY, OCTOBER 22, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

INDIAN SECTION.

FRIDAY, OCTOBER 15th; SIR CHARLES C. MCLEOD in the chair. A paper on "British Trade with India" was read by MR. THOMAS M. AINSCOUGH, O.B.E., His Majesty's Senior Trade Commissioner in India and Ceylon.

The paper and discussion will be published in a subsequent number of the *Journal.*

CANTOR LECTURES.

AIRCRAFT PHOTOGRAPHY IN WAR AND PEACE.

By Captain H. HAMSHAW THOMAS, M.B.E., M.A., F.G.S.

Late Royal Air Force.

Lecture II.—Delivered January 26th, 1920.

AEROPLANE PHOTOGRAPHY IN WAR.

The utility of aeroplane photography in war may be considered under three headings:—(1) The provision of information as to the enemy, his works, and his terrain; (2) the graphic record of the results of operations; (3) the production of military maps. The last subject may be reserved for the concluding lecture.

MILITARY INFORMATION.

Modern methods of warfare require precise and accurate information about the terrain occupied by the enemy, and about his works. This is especially the case in trench warfare, where no offensive movement has the slightest chance of success unless preceded by a detailed knowledge of every part of the trench system which is the objective, of all gun positions, positions of reserves, dug-outs, etc. Aerial photography provides the only known method of obtaining the required information with the necessary accuracy. Indeed, it seems impossible to imagine how the war could have been brought to a satisfactory conclusion after trench warfare had been established, without the aid of the aeroplane camera. The supply of intelligence by agents, or by the interrogation of prisoners, has become of less importance than the facts discovered by photography, and it was not only possible to photograph things seen, but to gather details which, while of little intrinsic importance, might give indications of the plans of the enemy. The air photograph not only tells us that the enemy possesses a certain work, but it also indicates exactly the position and size of that work, and enables it to be drawn in on a map or plan.

The appreciation of military information depends on the close study and ability to interpret aerial photographs. In vertical views, which are the most generally useful, the objects depicted on the ground have a quite unfamiliar appearance, and must be studied in the light of knowledge and experience. We are especially helped in understanding their nature by a consideration of the shadows which they cast, and also by the examination of stereoscopic pairs of prints depicting those objects. Successive views taken after intervals of time, or photographs of the same place at different times of day, may greatly facilitate the work of interpretation, and it is often quite unsafe to make a report from the examination of a single photograph.

It is especially valuable in detecting camouflage to use photographs of the same spot taken under different conditions, or at different times of the year, and often the most skilfully camouflaged position has been detected by comparison of a photograph of the work with one of the same ground before the enemy had commenced to alter it. Photographs taken immediately after a fall of snow frequently gave valuable information, for guns generally produce blast marks on the snow which are instantly recognisable.

The information supplied by aerial photographs is often much enhanced, if taken together

with that supplied from other sources. Especially fruitful has been the co-operation with sound-ranging and flash-spotting sections for the discovery of the positions of the enemy's guns and battery positions. It is also necessary to use a system of collating and collecting all evidence from photographs and other sources. This involves the employment of a method for registering the exact position on a print of all points of actual or doubtful interest, in such a way that the position of such points can be communicated to all those possessing copies of the photograph, and that it can be noted for future reference. A system of co-ordinates is employed for this purpose, and polar co-ordinates are more suitable than rectangular co-ordinates. The origin of the polar co-ordinates can conveniently be taken from the marks placed on the negative to indicate compass direction of the view, and this proved an easy and useful method which was generally used on the Palestine front.

The types of information which are required for military operations, and which are furnished by air photographs, are varied. In the first place, we may notice the very essential topographical information, the shapes and extent of hills and valleys, woods, marshes, lakes; the courses of rivers or wadis, the nature of their banks, the presence of bridges or fords; the occurrence of towns and villages, their shape, nature, streets; the presence of gardens or orchards, hedges or walls. It is usually quite easy to ascertain all these points from photographs, especially if we have series of stereoscopically paired prints to work from.

The details of the enemy's works may be ascertained to a considerable degree of completeness. Trenches of various kinds, barbed wire entanglements, listening posts, dug-in shelters, etc., can usually be made out without difficulty. Dug-outs and pill-boxes require more careful search and deduction; breast-works may be distinguished from trenches by the study of the shadows which they cast.

The positions of the enemy's guns were often located without difficulty in the early days of the war, but as time went on, and camouflage methods were devised and improved, the search for gun-positions became more difficult, but seldom fruitless. Gun positions are often revealed by the disturbance of earth, by suspicious tracks to their vicinity, by blast marks, telephone cable trenches, and many other indications. If the locality can be photographed several times, and was taken before being occupied, it is unlikely that the battery will escape observation, and it can be dealt with by our gunners. The positions of machine guns are often more difficult to locate, but they usually have certain characteristics which may be recognised. Trench mortars of the larger sizes can generally be found.

The study of the communication trenches and of the roads, tracks, etc., leading up to the front line, is often of first importance. It not only reveals the position of reserve troops and billet areas, but frequently indicates the division of the front into sectors, and gives a clue to the organisation of the troops who are holding the line.

The study of trench history, and the observation of additions or improvements made in the works, often gives useful indications of the enemy's beliefs or intentions. It may appear that he is devoting much labour to strengthening his works, expecting to be attacked, or on the other hand, he may give evidence that he is contemplating an offensive movement.

The roads and railways leading to the rear of positions must always be accurately known and watched; near these heavy guns may be found, dumps may be constructed, bivouac areas may be established or hospitals placed. In addition to these, a detailed knowledge of both the organisations and the nature of the country is important for aerial bombing operations.

The system of telegraph and telephone communications is sometimes revealed in a remarkable manner by aerial photography, and may give valuable information. On the Palestine front, near Gaza, the Turks or their Austrian gunners constructed shallow trenches a few inches in depth to hold their telephone cables. These showed up very clearly in photographs, and revealed the artillery organisation of the sector, indicating the occupied battery positions, the observation posts, command posts, infantry headquarters, etc. In some cases even air telegraph or telephone lines may be distinguished by the shadows of the poles, or the disturbed or uncultivated ground at their bases, or by the tracks of the linesmen.

The rear organisations are often easy to make out, though their details may not provide more than speculative interest. Railway stations, ammunition dumps, aerodromes, camps, etc., can be studied closely from photographs. In the same way harbours, submarine bases, and docks were often revealed. It is indeed difficult to hide anything from the aerial camera, which is the all-seeing eye of the aeroplane, and which

records the most minute details. Nothing can be really hidden unless underground or within dense woods, or in buildings which have been erected for some other purpose.

This fact has correspondingly influenced the disposition of military objects, and necessitated a very careful study of the principles and methods of camouflage.

Results of Operations.

The second great function of the aerial camera is to record the results of operations, such as bombing or bombardment. After such an operation has been carried out, it is of the utmost importance to know the degree of success which has been achieved, or the exact amount of damage which has been done.

A photograph of an enemy battery position, taken after it had been shot at by our guns, showed where the majority of the rounds had fallen, and enabled the battery to be classed as destroyed, damaged, or uninjured. For such a purpose a photograph is much better evidence than an observer's report. One method of carrying out a destructive shoot upon a position is as follows. The position is photographed and the guns fire about ten to twenty rounds upon it without altering their range, after which a second photograph is taken. Examination of the prints enables the mean point of impact of the shells to be determined with reference to the target, and from this the laying of the guns can be corrected so that the mean point of impact shall coincide with the centre of the target. The correction is applied to the guns, and a large number of rounds are fired without further observation; if the guns are capable of maintaining their accuracy a highly destructive result should be produced. This method was frequently employed by German gunners.

The effects of an intensive artillery bombardment of a trench area are well shown by photographs, and the systematic destruction of the enemy's works was often regulated by this means. Photographs taken before and after a bombardment show in a very striking way the awful and destructive effect of a modern artillery bombardment. Houses, trees, trenches, wire, etc., all disappear under the effects of the shells, and a pitted mass of confused shell-holes is all that remains; subsequent photography may display the efforts which are being made to reconsolidate the position by the occupation of shell craters and their connection by small lengths of trench or shell holes produced artificially. Photography of this description would often precede the final assault of a position following a bombardment, and in such a case speed in obtaining, developing, printing, and despatching the prints to headquarters is most essential.

In almost all operational work the value of photographs is lost if their production is delayed, and our Air Force photographers were trained to despatch prints from a batch of negatives in something like one hour after the plates were sent in. During the Gaza-Beersheba operations of October 1917, the Beersheba sector was photographed daily about noon; the prints were produced, examined by the intelligence staff, and the new positions and latest information drawn up in map form shortly afterwards, this map was copied by photography, and copies of it were dropped by an aeroplane on the headquarters of all units in the field about 5 p.m. on the same afternoon. While there is nothing of particular note about this performance, it serves to give an idea of the way in which aerial photography assists the army, and puts commanding officers in possession of the latest intelligence about the front in a very efficient and rapid way. By this means great precision is gained which is essential to the success of operations under modern military conditions.

The camera is an essential adjunct when aeroplane bombing is being carried out, because it provides a means of ascertaining what damage has been done by the bombs. In the excitement of a large raid, it is almost impossible for pilots or observers to note exactly where their bombs fall, but the photograph not only shows the damage done, but the craters left by the wides. Numerous examples have been exhibited in public showing the results of aerial bombing as indicated by photographs, and among the more striking have been those depicting an attack on an ammunition train, and those showing an attack on a reservoir.

The Relation to Strategy and Tactics.

It has been pointed out above that the aeroplane camera has introduced a great element of precision in the operations of warfare. In the past commanders have usually contested for the occupation of commanding points, from which a view of the opposing forces could be obtained; but the aeroplane has greatly diminished the value of such points, and air photographs give to commanders a very much better view of the enemy's dispositions and terrain than could ever be obtained from the ground. In this way, both strategy and tactics

have been influenced. It is now possible to gain so complete a knowledge of the positions of the enemy that, as is well known, a hostile position can be reproduced behind our own lines, and a proposed attack can be rehearsed in almost every detail. By such rehearsals the plans for the attack are not only perfected, but the attacking troops become so familiar with the position and works before them that they are able to carry out an assault in the dark.

Aeroplane photography, together with sound ranging, has provided a means of combating the efficiency of modern artillery, and by providing a good means of detecting battery positions, they have contributed largely towards the saving of life, for an attack without careful preliminary counter-battery work is a costly business.

Quite apart from the revelation of enemy dispositions, the aerial photograph has helped much in the preparation of the operation orders and plans for an advance. By the aid of vertical and oblique photographs, and especially of stereoscopic views, the lie of the country is revealed. The exposed spots are shown, as is also the position of cover and dead ground. On many occasions commanding officers have testified to the help given by the study of aerial prints in disposing their men.

Another way in which the aeroplane by camera and bombs may have a definite influence on strategy, is shown by the operations of the troops under Field-Marshal Viscount Allenby in Palestine during September, 1918. An attack was arranged and carried out with the object of driving the Turks out of their entrenched positions on the coastal plain, and at the same time cutting one of their main lines of communication by an encircling movement. The Turkish and German reply, which had been previously arranged in event of this movement, was a withdrawal to the hill country, which abounded in natural defensive positions and possessed few roads. This plan was frustrated, and the withdrawal into the hills became a rout and a débacle in the following way. The roads leading through the hills, along which the troops and transport could pass, had been carefully photographed and studied with the aid of the stereoscope. It was ascertained in this way that they possessed certain sensitive portions; on two of the roads there were bottle-neck valleys, where a steep hill-side came down to the road for a few hundred yards on the right hand side, and a stream bed occupied most of the space on the other side of the valley.

As soon as the Turkish retirement was commenced, and the main body of troops reached these points, they were violently attacked by our aeroplanes with bombs and machine guns. Escape was impossible, the road became blocked, and troops and transport from behind came crowding up into the bottle neck, to furnish a fresh target to new aeroplanes which were coming up with their deadly freight of bombs. In the course of a few hours, after undergoing this experience, a Turkish army was entirely broken, demoralised, and ready to surrender. A second army met with a similar fate on another long road, by which it was endeavouring to retire to the Jordan. This road was also known in detail, owing to careful photography; it ran down a valley, and possessed a very vulnerable point at the bottom of a long descent where the road crossed over a stream bed. Here again the way was blocked by the effective bombing of some motor lorries at the crossing, and the troops and transport on the road behind were brought to a standstill, where they remained absolutely at the mercy of our attacking aeroplanes, which wrought frightful havoc among them. This army was practically destroyed, and almost all its transport and guns was captured.

The points of general strategical importance which emerge from this operation are, first, if an army can be forced to retire by a route through a sensitive position, it may be seriously damaged by an attack; and, secondly, that the aeroplane camera provides a means of discovering those points which may be regarded as sensitive, and at which an air attack may best be delivered. Points such as those, which are here called sensitive, may be found along almost any road which runs through hilly country.

In this respect, as in others, the careful photographic survey of the topography of the country—which can be so readily effected by the aeroplane camera, as will be described in the next lecture—is bound to have a great influence on the military operations of the future.

WOMEN'S POSITION IN INDUSTRY AFTER THE WAR.

The "Annual Report of the Chief Inspector of Factories and Workshops for the year 1919" (Cmd. 941. 1s. 6d. net) contains the following observations by Miss A. M. Anderson, C.B.E., H.M. Principal Lady Inspector:—

Any complete summing up of the women's position in industry in 1919 is extraordinarily difficult owing to the presence and working of various contrary

currents, favourable and unfavourable, both to the retention of women and extension of their employment in relation to new developments of trade, and in some instances to their re-settlement in their old industries. These currents have varied in intensity in different parts of the country, and in different branches and groups of industries. The variations naturally affect the conclusions of the Inspectors reporting. Most are agreed as to certain outstanding features: (*a*) that the year must be regarded as a transitional and abnormal year, particularly in the sudden falling away of employment for women in engineering industries, and as substitutes, before large branches of their own work had time to expand; (*b*) that in spite of all the difficulties that had to be encountered in the turnover from war production to civil production, the strikingly unselfish readiness of the women to yield place, even in the work where they had altogether made good, to the returning men, greatly helped to facilitate the transition. "In peace-time industries, where women had been replacing men on well-paid work, the temptation to remain must have been great, and it says much for the . . . women that here, too, they left cheerfully as the men returned" (Miss Slocock). The change back has been effected with far less effort than was the earlier change from civil to war production, and this is largely an effect of the careful substitution agreements of employers and workers made in so many industries under guidance of the Factory Department (Mr. Jackson); (*c*) that many younger employers returning from the war have a new outlook as regards need for fresh methods of production and new vision as regards workers', and particularly women workers', needs. As one said to an Inspector, "We have seen the impossible undertaken and accomplished . . . and now we want to carry on here." The Inspector adds, "Out of the materialism of war there has emerged in individuals a wider spirit of toleration which is very wonderful to watch" (Miss Coombes); (*d*) that friendly as the relations have been in the past between Inspectors and both workers and employers, there is a new eagerness on the part of employers to have frequent visits from the Inspectorate. "I have come across two or three ex-officers starting new ventures expecting an Inspector's visit, and willing to co-operate in what must be a new spirit of comradeship" (Miss Gwynne). "Letters from occupiers expressing thanks for instructions and help given are by no means uncommon" (Miss Escreet); (*e*) that employers are awakening to the need of starting new factories for women's recognised industries in places where employment for women is limited, and instances of hosiery and wholesale clothing factories in new neighbourhoods hitherto lacking women's trades are specially noted; (*f*) that in the later months of the year the supply of labour for the older industries was growing more normal, as wages rose for learners as well as skilled workers, and better conditions for welfare were developed; (*g*) in certain industries, such as the manufacture of corsets, blouses, shirts and collars and cardboard boxes, which were greatly reduced or almost in abeyance during the war, workers being diverted to war industries, there was an acute shortage of skilled labour, due largely to practical cessation of normal training during war-time. On resuming ordinary peace undertakings in such industries, the tendency has been gradually to make up the deficit by training young workers rather than by intensive training of older women.

In discussing the new spirit found in factories amongst employers which "promises well for the future," Miss Martindale refers to complaints that have been made regarding certain indications of slackness on the part of the women. "That a new spirit amongst the women should not be so clearly definable as amongst the employers is not surprising when one remembers what a profound upheaval in their lives the war has caused. During the war women's powers and capacities were called into full play, and no one denies that there was a response beyond all expectation. To-day there is little call to a strenuous and sustained effort, entailing full use of powers and faculties. Instead, interesting work is taken out of their hands, and they are being forced back into the routine of their hitherto normal occupations. Some employers, keen to produce, are not inclined to regard the point of view of the woman employee with much patience, others have grappled with the situation by making efforts to open up new avenues of employment for them" (Miss Martindale).

In a factory employing many young women and girls in new and old processes, most of whom have been munition makers, a capable welfare supervisor observed to me that unquestionably there was at the beginning of 1918 a slackening of energy, due to over-fatigue in the making of munitions and to a mental and physical reaction from the strain of the war. A considerable proportion of the girls had to be sent to convalescent homes to recover health and tone, but by the end of the year returning strength and vitality was noticeable, especially in the girls employed on new lines of work. Here not only were they encouraged to show initiative in suggesting modifications of patterns for the varied articles they were forming in coloured "erinoid," but they were also enabled to attend technical continuation classes and to develop physique by means of drill, dancing and other recreation.

Cotton and woollen textiles, hosiery, boot and shoe, hats and wholesale clothing, stand out amongst all other industries in the demands they have made during 1919, especially in the later months, for women's labour. If more systematic intensive training could have been undertaken in textile factories at the beginning of 1919, of girls of 16 to 20 years, who had in many cases no trade other than munition making, the industries as well as the women would have gained. The shortage of women's labour has been marked

throughout the year as the housing difficulty remains, even though improved wages and welfare conditions have removed part of the earlier obstacles to inflow of labour. "One or two large woollen manufacturers have attempted or considered the provision of hostels, but women do not take kindly to hostel life, except perhaps as a war emergency measure" (Miss Slocock). Limitations to the supply of new machinery and shortage of women's labour are severely felt in the Halifax district, and throughout the West Riding there is a shortage of the very necessary burler and mender. In Huddersfield, accumulation of pieces due to this cause has resulted in overtime beyond the 48 hours week (Mr. Wright).

As regards cotton, in some districts the number of women in the mills is greater than before the war. "In the Burnley district demobilised men are not returning to weaving, and there is therefore a large increase in the numbers of the women employed" (Miss Andrew). "The whole of the cotton industry is booming. Many firms have orders on hand which will absorb a whole year's production. In the weaving branch there is a shortage of weavers and looms are in consequence idle, yet there is talk of new sheds being built" (Mr. Jackson). In the linen textile trades in Scotland, in spite of the great demand, work is hampered by want of flax and shortage of weavers, so that looms are standing idle in nearly every mill (Miss Meiklejohn).

In wholesale clothing, special training factories organised by the Ministry of Labour in Yorkshire have facilitated the drawing in of much-needed women's labour, and manufacturers are taking the women over when they are trained. In the Manchester district the clothing trades have vacancies for many more workers than they can secure. "In the felt hat trade of Stockport there is a notable dearth of trimmers to whom falls the pleasantest work and the highest wages, so far as women are concerned, in the industry" (Miss C. Smith). "In Leicester the hosiery and boot and shoe trades could absorb several hundred more workers if they could be suitably housed, and the Chamber of Commerce have approached the Municipal Authority in regard to provision of hostels" (Miss Escreet). Another flourishing industry employing an increased number of women and girls is the gloving industry in Yeovil, where manufacturers are providing special teaching by a woman of experience (Mr. Shaxby).

Several more or less luxury trades are mentioned by Inspectors as affording a field for increased employment of women, *e.g.*, sweets, cigarettes, jewellery. Production on an increased scale in some places and as a new industry in others, gives fresh or extended employment for women or girls in several useful directions: *e.g.*, de-seeding and scutching of flax in South-Western and South-Eastern England (skilled and fairly heavy work), factory dairying in South-Western England, milk products, household hollow-ware making, pencil factories in Cumberland.

The glass industry is one of those into which women entered in a new way as substitutes during the war, and in which they have necessarily continued to a considerable extent throughout 1919 under more or less emergency conditions, owing to shortage of men and particularly to insufficient boy labour; although in Yorkshire use of automatic machinery is changing the trade, apparently not much general progress has yet been made through development of improved methods of manufacture in careful application of women's capacities to branches of the work particularly suited to them, although in the lighest branches of glass-blowing they appear to have done exceedingly well, *e.g.*, in test-tube making. The interesting provision for Glass Research in Sheffield ought to make future progress in this direction possible.

In the Potteries and elsewhere makers of tiles and sanitary ware and other goods for the building trade are very busy. The numbers of women employed in a considerable number of potteries visited by Miss A. Smith were very little less than during the war, when they were working as substitutes for men.

In the skilled dressmaking retail trades there does not appear to be any expectation of return to conditions at all similar to those before the war. There is complaint both of lack of supply of skilled workers and of decreased demand for production. Thus with the rise in wages there is a movement on one side for occupiers to limit the work undertaken to what they can do alone, or on the other towards going into partnership to reduce expenses. Application of electrical power is extending in the larger dressmaking establishments. Milliners' workshops in the old sense have almost disappeared, outside London and a few of the greater cities, the trade being absorbed by the wholesale producer and distributor.

A certain amount of transference of women's work to changed production has occurred in factories engaged on munition work during the war. For example, one national shell factory is used for manufacture of cardboard boxes; aeroplane and other munition factories have turned to motor-car and cycle production, where women are employed on accessories, or to production of sewing machines, or tin box making, where a few women remain as assistant fitters. Two aeroplane factories have been converted to wooden toy manufacture and to watchmaking and small electric instrument making, in which it was hoped that a large number of women might be employed.

Apart from a few scattered examples of this kind, too little thought seems to have been given by those discharging women, to what might be done in the way of adaptation of work for them or improvisation of training to prevent their unemployment. On the whole, the position is simply that "women have almost disappeared from engineering works" and "the women who were employed during the war in metal-working processes in substitution for men have mostly

gone . . . their places so far as still available are filled by demobilised soldiers and youths. . . . The women have all left the heavy iron trades of South Wales, except a few employed as sweepers at a set of blast furnaces. No women are known to remain as drivers of overhead cranes" (Mr. J. H. Rogers).

One of the women's special trades, the laundry trade, has gone through a difficult year. In the South-Eastern Division the trade has not shared in the general activity of demand, and it has been difficult for occupiers to obtain sufficient work. The great shortage of women's labour experienced during the war has steadily lessened in 1919. Although conditions have already considerably improved in laundries, much has yet to be done to obviate wasteful organisation which hampers development of comfort, safety, and health. "In certain streets there are several very small factory laundries, each with its own boiler and engine, any one of which could probably produce power and hot water for all the laundries in the street, each has its own van, and in each the occupier slaves from early morning till late at night as engineer, stoker, washhouse man and van man. In each the wife is forewoman and sometimes packer, in addition to her household duties, and is far harder worked than any of her women. Co-operation and sub-division of work might be developed with very much less waste of energy and fuel, and one would imagine with much more comfortable lives resulting without reduction of output or income" (Miss Pearson). In a Yorkshire laundry, women have been substituted by disabled soldiers in collar polishing, starching and packing, as well as in the washhouse, and the manageress expressed satisfaction with results.

Whereas in some cases employers have wisely established new factories for women's trades, clothing, textile, confectionery, etc., in localities where there was a surplus of women either through local lack of their trades or a sudden cessation of war industry, on the other hand an acute shortage of skilled women has, for various reasons, been seen in certain industries and places. A new recognition is growing up and spreading of the vital importance of securing well-distributed balance of the sexes for unhampered, healthy development of industry. In certain places, as Mr. H. J. Wilson points out, this lack of balance has assumed an extreme and serious form.

"In areas," he says, "where women's employment predominated, such as in the textile centres, manufacturers cannot, even by advertising and offering all manner of inducements, secure a sufficiency of female workers. It would actually appear that an adequate number of women does not exist to staff the vacancies, at least not in the localities concerned, and owing to the extreme difficulty of securing lodgings, girls from a distance are not attracted. Manufacturers and municipalities, too, are recognising now that unless there is a reasonable balance in the demand for both men and women in any given locality, the industries in the end suffer from a shortage of one or other, and general development and prosperity are impossible. To compensate for this difficulty hosiery factories have been started in mining and other areas where men are predominantly employed, and conversely shipbuilding has been developed in such centres as Dundee and Londonderry and Alloa, where the bulk of the employment was for women. It is obvious that successive generations of young girls, so necessary in the textile trades, cannot possibly be forthcoming if there is not employment for the fathers of families. Yet this fact was not much recognised in the past, and certain centres, such as Dundee and Hawick, are to-day suffering acutely from lack of young women necessary to keep their plant fully occupied. Industries in the past have grown up somewhat haphazard with a tendency for factories manufacturing the same type of article to concentrate in the same town or locality. There were no objections to this so long as the industries concerned gave approximately equal employment to the two sexes. On the other hand, if the demand for one sex predominated there was difficulty in satisfying it unless workers were brought from a distance by rail or tram. This position is marked at present in the following centres in this Division: Dundee, Dunfermline, Hawick, Galashiels, and certain areas in the north of Ireland. On the other hand, in the iron-producing towns there is an unsatisfied demand for men and insufficient local employment for women. Women, however, appear reluctant to leave home and live in lodgings; they prefer local employment, consequently if their services are to be utilised it will be necessary to bring suitable industries to their neighbourhood."

PAPER PULP SUPPLIES FROM CHILE.

Some interesting information concerning the paper pulp supplies of Chile are given in the *Times Trade Supplement* by the *Times* Special Commissioner in Autofagasta.

Chile, he writes, possesses 15 million hectares of wooded land, or about 32,000,000 acres, stretching from the islands of the far south to Central Chile, but gradually thinning out north of the province of Cautin.

When I recently visited these forestal regions I was impressed with the density and extent of the tree-covered areas. They are like wide green seas, filling mile after mile of shallow valleys, extending to the feet and up the sides of the Andean spurs; they are thick with ferns and tangled with wild bamboo (coihue or quila), and among many useful timbers there are quantities of such conifers as the alerce and cypress, together with the Chilean pine (Araucaria) of the mountains, suitable as producers of pulp for paper-making.

Two-thirds of this wooded land must, however, be left out of any consideration of Chilean forests available as the basis of a paper pulp industry.

The northerly areas above Santiago produce only small trees, insufficient for local needs as regards fuel and industry—the thorny algarrobo, of the mimosa family, whose pods supply a tannin similiar to that of the Venezuelan dividivi; the quillay, whose saponaceous bark has a wide sale, and the litre, a small fuel-wood. The wooded areas of the central area show, especially in the well-watered regions of Aconcagua, O'Higgins, Valparaiso, and Colchagua, lingue, rauli, luma, and maitén, some boldo, and native oak (roble), the laurel and luma being found as the south is approached. Below Concepción the woodland is thicker, the trees larger, and in Cautin province piles of logs and planks at every railway station denote the presence of the saw-mills that extend to Puerto Monte, to Chiloé island, and to Punta Arenas. More than half of Chile is unable to supply its own timber needs; it is in the great southerly regions of the alerce, the coihue, and the Chilean pine that vast quantities of wood for industrial use must be sought.

Of such primeval, heavily-timbered country there are about four and a half million hectares, or nearly ten million acres. Immense districts are still untouched for lack of adequate transport, although it should be remembered that the narrow shape of Chile, and the large number of southerly rivers and lakes help to render the problem of transportation soluble. The average width of the country is but one hundred miles; through the long north-and-south valley runs the State railway; and there is an abundance of water power available for industry.

Varieties of Timber.

Forty per cent. of the whole territory of Magallanes is thick with forest; the provinces of Chiloé, Llanquihue, Valdivia, and Cautin are also rich in useful trees. Before the war Chiloé island had begun an export of cypress and luma to the United Kingdom. All the lake country is thickly covered with canelò, coihue, and alerce; the two latter are the tallest trees found in Chile. They have been pronounced, together with the Chilean pine, excellent material for paper-making. Coihue of the "white" variety grows in huge quantities. The alerce is a fine conifer, also growing in extensive groups; it yields a red wood resisting exposure to air and water, is light, elastic, and easily worked. The trunk frequently measures from four to five feet in diameter; under the outer bark is a secondary layer heavily charged with resin. This wood, which is employed in the construction of native boats, obviates the use of tar.

There are no forestal laws in Chile, and in the south the woods are of such extent that cleared ground is considered more valuable; as a result, great areas have been, and are being, ruthlessly burnt to afford land for cultivation. Of late, however, many enterprising landowners have begun to plant woods of spruce and eucalyptus, quick-growing trees that have readily become acclimatised in Chile, as have also the poplar and the willow. Any industrial scheme for the production of paper pulp should include an afforestation plan, or the time will come when even Chile, prodigal with her woodlands, will face the same shortage experienced by many countries to-day. A fine forest region such as this of South Chile has not escaped the attention of industrialists, and several suggestions have been made for the establishment of a paper factory using native pulp, but all have so far come to nothing—probably owing to the war.

Attempts at Development.

A Swedish firm is upon the ground making surveys and experiments. Investigations made by a German group prior to 1914 showed the suitability of the coihue and pine, but subsequent plans fell through. The tentative work of French interests also remains without definite result. There are two or three paper factories in Chile, but the material used is chiefly old paper and rags, with a quantity of imported wood pulp; no fine paper is manufactured, the product consisting chiefly of brown wrapping paper or cardboard.

The Chilean market is, by itself, limited by the small population of the country, paper imports reaching a value of about £500,000; but a paper manufacturer operating on a large scale at such a base of supply would seek world markets, and in face of the present shortage of paper pulp, would have every reason for optimism. Water and water-power, ready access to sea transport, and good if not plentiful labour, are among the advantages to be counted upon; the disadvantages are chiefly connected with the heavy rainfall in regions which sometimes count from 40 to 100 inches in the year, rendering the seasoning and drying of timber difficult. It is scarcely necessary to say that these localities should be ascertained and avoided, and that any investigator should judge by the weather not in December but in July the middle of the wet season.

Prospect of State Support.

Much of Chile's forestal land is in private hands, although undeveloped, and has acquired a value since the south was opened up sixty years ago by European immigrants. There are, however, large tracts still remaining under Government control, and it is towards these that an enterprising industrialist would first look for material. The cordial assistance of the authorities in the establishment of a paper pulp factory could, I am assured, be counted upon.

Chilean forests cannot remain neglected for many more years. When the price of paper has soared to such extraordinary heights, and the world is being searched for new sources of pulp, a great area of such quality commands attention: it is not only great, but one of the greatest available sources of timber supply left to mankind. It is too rich and too urgently needed to escape industrial use. British industrialists who have sought raw

materials all over the earth and who have carried enterprise into both hemispheres should turn attention to this great woodland area before the opportunity has passed.

BRITISH LEATHER TRADE: SUPPLIES OF RAW MATERIAL.*

Unless the demand for leather continues on its present low level there will be a serious dearth of hides. The enormously increased outlay necessary to procure a herd of young cattle, the very much enhanced prices of all feeding stuffs, and the almost universal shortage of money, are all factors making themselves felt in the cattle situation. In our own country cattle which could be purchased for £17 to £20 in pre-war days are realising £60 to £70 every week, with every prospect of the price becoming still greater. The inevitable result will be a gradual diminution in the stock of cattle, and this has already commenced. Many papers commented on the very serious decrease in the total number of cattle in the kingdom, as revealed by the Board of Trade figures for 1919. The frigorifico or packer kill of cattle at the River Plate fell off 22 per cent. in 1919 as against 1918, and the foot-and-mouth disease and floods out there have somewhat depleted the herds. It is estimated that there are 7,000,000 fewer cattle in Europe than before the war. Calves are being killed off to a greater extent than ever before because feeding stuffs are so expensive, and many farmers have not the capital necessary to lock up for months in this way, so that there does not appear to be much likelihood of any improvement in the near future.

There are large numbers of cattle in Asia, Africa, and Australia, and some of these sources have already been well tapped. Hides are imported into this country from Mombassa, China, Java, Sumatra, and India. There are large numbers of cattle in Uganda, Rhodesia, British East Africa, the Sudan, and the old German South-West and East African Protectorates, and the hides of these districts are all available for export. Sudan hides are usually half tanned. The tanning materials employed are native products, which are easily washed out, and the hides are therefore very suitable for chroming. The leather is then very similar to full chrome in suppleness, but grain is poor and drawn. It would be much better to establish collecting stations for both these hides in the raw state and also goats. As we shall note later, there are tremendous quantities of tanned goat skins exported from these regions, and the value of the finished leather would be greatly enhanced if the raw skins were exported to some first-class leather-producing country. The best would then be made of them, and this is very essential in these days of an insatiable demand for the very best, with no outlet for inferior goods.

Large quantities of hides and calf skins have been arriving in this country from Mombassa, the port of British East Africa. The quality of these goods is very good on the whole. At present a difficulty arises in the disposal of the lower grades. It is necessary to take original batches to secure a delivery. These may contain up to 50 per cent. and more thirds and rejections. The better grades, however, are really capable of giving good serviceable leather. The skins are well dried and cured, and there is very little, if any, waste arising from faulty drying. The grain of the best skins is very fine, and such skins make beautiful box leathers, which even if they are not box calf are very little inferior to it. Some of the more enterprising tanners in the country are keeping a close watch on this portion of our Empire, and I understand that some have sent out their representatives to arrange for the collection and despatch of the material from Mombassa.

China exports dried hides, and I have had the opportunity of working on some and inspecting many other parcels. They are mostly well-grown hides, of good, even substance. They are not suitable for sole leather, but are just the thing for dressing leather. They make excellent dull chrome upper leather and combination chrome football leather. Most of them are well preserved, but there are many which have been badly dried, and blister in the soaking-down and liming. It is difficult to estimate the value of parcels of China hides owing to the occurrence of this defect and the uncertainty which surrounds them. It seems to have created quite a bad reputation for these goods, despite the fact that many of them are of excellent quality. Some very choice dressing hides are exported from Java and Sumatra. They are well dried, and yield some choice leathers.

Australia seems to have been neglected by the heavy leather tanners and dressers of these islands; and yet it is no mean cattle rearing country. The total number of cattle in the Commonwealth was over five millions in 1901 and over twelve millions in 1910. Of these five million cattle the larger portion were reared in the Eastern States, Victoria, New South Wales, and Queensland. Besides the cattle butchered for domestic requirements there is a fair-sized canning industry in Queensland and New South Wales. The hides from the Australian cattle are very large, though not of the best quality. Large parcels of box sides were imported into this country last year from Australia. The feetage averaged over 40 ft. per hide, they were well chrome tanned, of very even substance, having been split and remarkably well finished considering the quality of the grain, which was rather inferior. The dressing was somewhat of a revelation, for it is only six years ago that an Australian tanner confessed to me that the quality of their manufacture was very much behind ours.

The last, but not least, source of light hides or kips is our dependency in India.

* Extracted from article by "Prefex" in the *Leather Trades' Review* for October 6th, 1920.

EMPLOYERS AND EMPLOYEES.*

As a rule in speaking on such subjects as Production it is usual to deal first with the machine and then with the man. I think this is reversing the importance of the subject, and so propose first of all to deal with the human side.

It is not necessary to explain why it is needful to deal with this side, although a comparatively few years ago it was of secondary importance. The whole trend of the movement of the world is in the direction of study of the individual and individuals, and Chairs of psychology are springing up at various Universities. Associations, such as the Industrial League and the Industrial Council, now happily amalgamating I believe, are giving serious attention to the various phases of psychological study. This joint Association is, I think, one that should receive every encouragement. Lately the League and the Council have considerably extended their scope by forming branches in various towns, and this gives an opportunity of meeting local labour leaders outside the Conference Rooms, and of discussing views at more leisure than is possible when some particular case is being dealt with.

I do not, however, propose to go deeply into the theoretical side of the question, but to discuss it chiefly as it appeals and appears to a practical engineer dealing day by day with men and materials. As an old chief of mine so truly said when he was giving me my first charge of men after having had charge of the testing and inspection with a large firm: "In the past you have dealt with many intricate questions in connection with material, now I am going to give you a much more complicated job—I am putting you in charge of men." We have all of us given—if often unconsciously—some attention to the subject, for when serving our time we were always considering and studying the state of mind of our "mate" or our labourer, and this was probably the greatest education we had in our shop experience. If we benefited by it as we should have done, we appreciate to some degree the thoughts and aims of those we are now in charge of. I say "to some degree" advisedly, for changes take place in the ideas and ideals of labour, and probably no period has seen so great a general change as that which has taken place in the past six years.

Originally we bargained or dealt with individuals, then with fairly small groups, but now we are often only a unit in a body which discusses matters with the representatives of very large bodies of men, oftentimes of very diverse trades and occupations. I think, however, that it may truly be said that the greatest asset which a man can have in these dealings, whether with an individual or with the whole of a trade, is to have a reputation for fair dealing. This may seem to be a truism, but there are times when an oversight gives him an advantage, if he desire to take the word rather than the spirit as the proper interpretation of an agreement. I do not think that labour disputes the right of the other side to fight hard for what they believe are their rights, and they expect the same consideration to be given to them.

There have arisen during the past few years various systems of getting in touch with labour, and although the general methods are still to some extent heterogeneous, they approximate broadly in the engineering trade to a huge Whitley Council. The organisation of this latter is probably well known to all, and in certain specified trades it is said to be working well in its entirety. I do not wish to deal with it or with the larger organisations in our own industry, but with matters which affect our own individual works, and then to deal with a few other matters which affect labour and work in our shops, which will perhaps be looked upon as details.

I must first of all deal with Shop or Works Committees. The constitution of these is not standardised, and it is questionable if it is really desirable that this should be done. Every shop varies in its physical geography and in the distribution of its labour; the main point is that every employee may be fairly and truly represented, and that the Committees are not only representative but have the confidence and respect of those they represent. As a rule all questions of rates are settled for the firm and the employees by conferences covering larger bodies, but points of classification are sure to crop up from time to time, and it is well if these are, as far as may be, settled for every man on the ground. It is doubtful if it is desirable for any definite intervals to be fixed as the maximum for meetings between the management and the committee: the better arrangement seems to be that they shall be called at any time either side desires. In many cases the whole of the Committee need not attend, but possibly the Chairman or Deputy Chairman, the Secretary and one or two of the members concerned, together with any individual who has special knowledge of the matter under discussion, may meet one or more members of the management.

Some may argue that there is nothing left nowadays for such a Committee to deal with, as settlements are so general, but I believe there never was a time when they were so necessary. Questions with regard to the interpretation of agreements and the putting into operation of awards are constantly cropping up. Points dealing with classification of men and the hundred and one little matters which occur in a works have also to be dealt with. It will be realised that if there is any cause of dissatisfaction in a works on the part of a group of men or even of an individual, there is nothing much worse from a production standpoint, and the time for dealing with it is as near its inception as possible. It may be argued that many points are trivial and will finally clear themselves up, but even if there were not the chance that an apparent triviality might grow into a serious trouble, this is surely not a sound argument

* Extracted from the Presidential Address of Sir Henry Fowler, K.B.E., to the Institution of Automobile Engineers.

when dealing with a bit of grit in the machinery of a works organisation. Not only so, but it can be said from experience that a properly organised Committee will frequently help the management by clearing away misconceptions which will always arise. In this, too, they are infinitely better placed than any management can possibly be. As was put to me at a works I had charge of a few years ago, not a tenth of the complaints raised with the Committee ever came forward, most of them were founded on mistaken ideas which the Committee were able to clear away without any representation to the management. The Committee, too, can be useful in disseminating information with regard to various matters which the firm wishes its employees to be acquainted with. Rumours of change of design, of trouble with material, of cancellation of orders, etc., are always unsettling, and a frank talk with the members will be helpful. My friend and late colleague, Mr. Webster Jenkinson, C.B.E., F.C.A., read on January 28th, 1919, before a Conference of the Industrial Reconstruction Council, a most interesting paper on "The Worker's Interest in Costing (a Factor in Industrial Reconstruction)." In this he dealt fully not only with the necessity of costing, but also with the desirability of enlightening labour more than has been the case in the past as to the state of affairs generally. In times past when shops were so small that the works manager was in the happy position of being able to address each employee by his Christian name, this could be done, and probably was done, by a word dropped here and there. We often sigh for those days when personal contact was possible, and it was felt that each one was a necessary integral part of the concern. Now with our huge shops and systems in management such a personal touch is impossible, but we may keep in contact with this side of our work through our Committees if we will only impress them and through them the other workers that we look upon them as men to be dealt with as men by men, and, as I have said before, that we are out to do a straight deal with them, not only when we want to be pleasant but on every occasion. It is so very difficult to get at the point of view of the other fellow, and we must make every effort to do so whenever possible. We are so apt to persuade ourselves that, because we once worked at the bench for a very few years a good many years ago, we understand what the mass of men feel today on every conceivable subject. I must confess that I was utterly unable to understand the workers' objection to payment by results until I read Mr. Sydney Webb's "The Works Manager To-day" a few years ago. One of my shop friends tells me it is already out of date, but if it is, it makes me more than ever ashamed at having to receive belated enlightenment from one who, according to his own statement, has never worked in a shop in his life.

I would like to refer, too, to the paper given by Mr. F. S. Button, A.S.E., Member of the Industrial Court, at the Manchester Convention of the Industrial League on June 16th last, on "Payment by Results." (Industrial League Journal, July, 1920, page 310.) The discussion on this paper, as well as the paper itself, is extremely instructive. I may be an exception, but I rather think that there are many others who would be glad to get an insight into the mind of labour. If we are to do this by direct contact, we must be willing to reciprocate in every way we can, and we must honestly endeavour to place ourselves in their position. In many cases this may be difficult, for the matter may seem to be so clear to ourselves, that we doubt that there can be any other view of it. Sometimes we read an article which on the face of it seems to be written in all sincerity, and which yet seems to be based on a foundation for which there is absolutely no justification. We could, in fact, probably think of technical articles to which this would apply. If we agree that the writer is sincere, these views, however we may disagree with them, represent the matter as it appears to him, and are therefore of value as showing his mind.

There is a question which naturally at once arises when considering the matters already referred to, and that is, who is to deal with this particular side of labour work? In the past Shop Committees have in their inception proved very successful as long as the heads of the firm have given them their personal attention. In some cases they have failed because for various reasons it has been impossible for this attention to continue with a large concern. In cases even to-day we see the engineering head spending so much of his time on these matters that the saying that "we are ceasing to be engineers and becoming labour administrators" seems to be justified in some instances. In America an effort is apparently being made by the appointment of employment managers of a higher status than some who are working under that name in this country. It has been stated that they should rank at least with the works manager, and it must be self-evident that if they are to deal with all employment questions, they must hold a high position on the staff, for the questions they deal with are of vital interest and importance. They must be in a position to deal with matters directly, unless they involve important principles, or the men will realise that it is futile to discuss matters which have to go to someone else for final settlement. There is in works of any size plenty for such an individual to do, for besides dealing with the Shop Committee he would look after employment generally, welfare work in its widest sense, the training and education of apprentices, and would be the firm's representative at conferences of employers on labour matters, and at joint meetings between employers and labour. One difficulty that is met with at present is that of finding suitable men for such a post. It goes without saying that they should be engineers well conversant with shop work and shop life. Beyond this it is largely a question of personality and character, but having

these three great and essential qualifications, they are all the better for training, and here perhaps the schools and courses of psychology, to which reference has already been made, might help. The whole subject is obviously at present in its infancy, but I cannot help referring to the work which Mr. B. Seebohm Rowntree is doing in instituting lecture courses for managers, foremen, etc., to meet and to hear and discuss various industrial labour problems.

One of the points which has a very direct bearing on the production question is that of "labour turnover." Although in automobile work there is, perhaps more than in any other large engineering industry, a similarity of the operations in various works, yet every man who is employed does not at once come on to full production. The result is that the less labour turnover there is the better. I have recently seen it stated in the *American Machinist*, of July 24th, 1920, page 1041, English Edition, that by studying this question the "turnover" per annum has been reduced by the White Motor Co., of Cleveland, U.S.A., from 63 per cent. to 24·28 per cent., which latter figure compares with an average of 300 per cent. for Cleveland generally. These figures may all seem high to us at the present time. It is true that the automobile industry is largely grouped in centres, but I think that there is no doubt that owing to the housing difficulty there is at present less movement of labour than there was before the war, and than there may be again when the housing problem has been solved.

It may be a very small matter, but it is often found that in a works covering a large area, many of the employees even have only a vague idea of what takes place in other shops than their own. Their wives and children are absolutely ignorant as to the place where the head of the family spends an appreciable portion of his life. Many works could arrange that at holidays their shops should be open to any of their employees and their families who would care to visit them. This was carried out lately in the largest of the works I have charge of in conjunction with the Shop Committee, and great interest was shown.

Another point on which the employment manager will prove useful is in dealing with what is broadly called "Safety First." I think many of us whose works, under section 7 (1) of the Police, Factories, etc. (Miscellaneous Provisions) Act, 1916, which came into force on 1st December, 1917, and who now have a regular ambulance room and attendant, are astonished at the number of accidents which occur and require treatment each day, even if they are mostly trivial ones. These trivial cases if not treated at once may lead to serious ones, and should undoubtedly be dealt with at once, but it is naturally still better if they are prevented altogether. The "Safety First" Council is pushing the question of "Industrial Safety First," and here the co-operation and assistance of a Shop Committee is very necessary.

The subject of the education and training of apprentices has been dealt with from this Chair previously in a masterly manner, but I feel that I cannot refrain from pointing out that the new Act of 1918 imposes on us conditions which require the closest attention if they are not to interfere with the progress of our work. If we are to use labour of 15 and 16, and shortly up to 18, to the same extent as previously, it means that we shall have to increase the number of youths of those ages by about 20 per cent., and this means re-adjustment with ages above those mentioned. The matter is, we know, receiving the attention of the education authorities and of certain groups of employers, and doubtless of individual firms.

There is at present one point with regard to education which is in certain quarters a very serious one. This is the large number of young men who are desirous of entering the industry, and for whom suitable training facilities cannot be found. This condition of things obtained in the Electrical Trade some years ago, but not, I think, to so great an extent for a well marked reason. The motor industry resembles the electrical, as it was, in that it is practically new, and as such offers considerable attractions. The idea of speed also has a fascination for so many young men, and on the top of these attractions we have the results of the war. So many youths upon becoming 18 joined up, and at ages from 18 to 23 have left the army and are looking for training; they probably know how to drive a motor bicycle or a car, and think that this will be a good start towards becoming an automobile engineer. Some had before joining up already started training, and are anxious to go back to their shop. The result of this is that there is over-crowding, and many Appointment Boards, I believe, will not consider applications for training in Automobile Engineering unless the trainee has already obtained a trainer himself. It is difficult to find a solution, for most sides of the engineering profession are in the same state. Were this not so, it might be suggested to anyone desirous of becoming an automobile engineer that little if anything is lost in getting a training in a general engineering works, and entering the automobile side later on. This was done in electrical work years ago, and often-times successfully. There are numerous instances of some of the greatest advances in engineering being made by men who have come in with a fresh, clear mind from some other profession, or changed from one section to another of engineering work. The over-crowding is so great as to be a trouble, and the only solution would seem to be to stretch the capacity to the utmost in all cases. It may be said that we are likely to get more young men trained than can possibly find positions. We must remember the great wastage of this particular type of young man during the war, and although the competition for places will be keen, it is to be feared that it will be some time before we can ever make up our proper complement of well-trained men of character, and without these the country cannot progress.

NOTES ON BOOKS.

A NATURALIST ON LAKE VICTORIA. By G. D. Hale Carpenter, D.M., B.Ch. (Oxon.), Uganda Medical Service. London: T. Fisher Unwin, Ltd. 28s. net.

In 1910 the author of this work went out to Uganda to undertake an investigation into the bionomics of the tse-tse fly, and he stayed there, with a break of about a year's leave, until August, 1914, when he was suddenly called away to do duty with the troops on the Uganda-German frontier. During this comparatively short time he carried out a great quantity of exceedingly valuable work; and in addition to his study of sleeping sickness he was continuously observing not only the entomology of the country (though he is first and foremost an entomologist), but also its various birds, beasts, and fishes, and its human inhabitants. These records are now brought together in a volume which will undoubtedly possess the greatest attractions for all lovers of natural history.

The first two chapters give an account of sleeping sickness, and here we are grateful to Dr. Carpenter for quoting the earliest account of the disease which is known in print. It dates from 1742, and was written by a naval surgeon named John Atkins in a book entitled "The Navy Surgeon." The description of the symptoms might pass muster to-day, but the passages relating to the cause and the cures—among the latter "sudden plunges into the sea" are advocated—show that medical science has travelled some distance since John Atkins wrote.

For forty months Dr. Carpenter devoted his principal energies to an intensive study of the tse-tse fly. For this purpose he lived both on the shores of Lake Victoria and on the uninhabited islands where he could find "ideal conditions for studying *Glossina* unaltered by the presence of mankind and his surroundings." His account of the fly, its methods of feeding, breeding, etc., is of absorbing interest. Unfortunately, it is not possible even to summarise it here, and the reader must be referred to the book itself; but one may state that as a result of his investigations Dr. Carpenter comes to this conclusion: "In order to exterminate sleeping sickness two animals must be kept from each other—the Situtunga antelope from which the fly obtains the Trypanosome, and the fly which inoculates the Situtunga with the Trypanosome." He then proceeds to ask, can the Situtunga be exterminated? and the answer is that it would be almost impossible; but he thinks that a good deal can be said as to the practicability of exterminating the fly. He satisfied himself that by providing very attractive breeding grounds the flies might be induced to deposit their pupæ in the places selected for them, where they might easily be collected and destroyed. Fortunately, the fly is an abnormally slow breeder, and Dr. Carpenter is of opinion that by these means it might, in the course of some years, be exterminated.

Passing from the study of the tse-tse fly, the author proceeds to describe the scenery, climate, and life on Lake Victoria, and he gives an excellent account of a canoe voyage to its southernmost island. His chapters on mammals, birds, and reptiles do not need the apology which he offers for them, for, although they are comparatively short, they are full of first-hand information. In particular, his observations of monkey-life and of their various cries are full of interest.

A valuable section of the book deals with the colouration of insects, and many instances are given of protective warning and mimetic colours. The chapter on *Pseudacraea Eurytus*, one of the most remarkable polymorphic mimetic butterflies, will be read with intense interest by all naturalists. The author's patient observations and the success which rewarded them go far towards confirming the Darwinian theory of mimicry. The story of how he caught and reared "Toby," who ultimately developed into *Pseudacraea terra*, and gave the first proof by breeding that the forms of *Eurytus* known as *tirikensis*, *hobleyi*, *terra* and *obscura* are conspecific, deserves to take its place among the classic tales of scientific discoveries.

OPEN-AIR GEOGRAPHY AND TOPOGRAPHICAL MODELLING. By J. W. T. Vinall, A.R.C.A., and G. Linton Snaith, B.Sc. London: Blackie & Son, Ltd.

The value of drawing as an instrument of general education has been too much neglected in the past. Fortunately many of our best teachers now realise the importance of training hand and eye. Mr. Vinall has helped much to bring about this awakening, and we believe that the present text-book, if adopted by the schools, will do a great deal to train boys and girls in the elements of an art which, apart from its general educative value, is likely to prove useful to them whatever their future sphere of life.

The book is divided into three parts. The first deals with surveying and surveying instruments, starting with simple descriptions of scales and verniers, and working up to exercises on ordnance maps. Part II. deals with Panorama Sketching, and is designed more particularly for the use of army candidates. A somewhat novel feature of this section are the pages dealing with aerial navigation, including the study of cloud forms and fogs. Part III. is devoted to army modelling, work which was often found to be of great use during the war. Mention is made, in particular, of a little model of the Vimy Ridge: "Over this Lilliputian landscape staff officers of high rank pored for hours on end, and officers and non-coms. from the Canadian and British units which were detailed for the assault were coached in their parts on this wonderful model. Much artillery plotting was done over this fascinating plan. It deserves to be placed in some monumental niche, for beyond all question it contributed to a degree which it would be difficult to exaggerate to the splendid victory so often schemed upon its surface."

SLIDE RULES, AND HOW TO USE THEM. By Thos. Jackson, M.I.Mech.E. London: Chapman & Hall, Ltd. 1s. 6d. net.

Modern Slide Rules have become extraordinarily perfect, and as calculating machines they work wonders in the saving of time. They are of the utmost value to all whose work calls for the rapid solution of intricate problems which, without their aid, would call for long and tedious processes of decimal multiplication and division. In construction they vary somewhat with different makers, but the main features are much the same. In this booklet descriptions are given of different types of "Gravet," "Log Log," and some special Slide Rules. The general principles are clearly explained, and a number of exercises are given.

GENERAL NOTES.

GAS FROM STRAW.—A gas obtained by the destructive distillation of wheat and other straw is now being produced on a small scale at the experimental farm in the United States under the control of the Department of Agriculture. According to *The Engineer*, several valuable by-products are obtained, such as carbon residue, suitable for the manufacture of lampblack, potash, phosphates, and nitrogenous compounds. The tar and ammoniacal liquors are similar to those formed by the destructive distillation of coal. The results obtained are held to be sufficient to warrant further large scale investigation as to the possibility of designing a plant to produce the gas in sufficient quantities to allow a farmer to supply light and heat for his house, power for his stationary engines, and possibly for his tractor, from a small individual outfit.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH.—The Department of Scientific and Industrial Research have published, through H.M. Stationery Office, a report submitted by the Canned Foods Committee of the Food Investigation Board, dealing with the methods used for the inspection of canned foods and their reliability for the purpose as applied to canned meats. The report was prepared by Dr. W. G. Savage; it is the first of a series, and deals only with imported material; home products will be considered later. The report deals with the subject under the following headings:—Methods of canning of meat so far as they affect the methods of examination; methods of inspection in England at ports of entry; critical consideration of the reliability of the methods of examination employed. The report of the Inquiry Committee on the Standardisation of the Elements of Optical Instruments, now published for the Department of Scientific and Industrial Research by H.M. Stationery Office, contains the results of investigations made by a Committee which was originally appointed as a panel of the Departmental Standing Committee on Glass and Optical Instruments. Before publication the report was considered at a conference held between members of the optical industry and representatives of the department, and the suggestions then made by the industry were carefully considered by the Inquiry Committee before the final draft of the report was settled. The report is divided into the following main headings:—Unit of measurements; objectives for telescopes; diameters for lenses; prisms for prismatic binoculars; mirrors for sextants; level bubbles and mirrors for viewing bubbles; constructional screws; fine motion screws; metal tubing; screw threads for metal tubing, cells and other fittings; sheet metal and wire gauge; shafts and holes; gear teeth; worm threads and wheel teeth; drawings; designation of the standards. The report also contains three appendices entitled, "On the crossing of screw threads and on the zero of a screw," "on inspection of screw threads," and, "on the influence of errors in the prisms of prism binoculars."

NORTH AMERICAN WHEAT CROPS IN 1920.—The September Bulletin of Agricultural and Commercial Statistics of the International Institute of Agriculture announces that the United States wheat crop of 1920 is estimated at 21 million metric tons (14·5 million winter and 6·5 million spring wheat). The latest estimate of the Canadian crop is 7·9 million tons, while the stocks of old crop wheat in the United States on July 1st were 4·1 million tons. The aggregate North American supply of wheat for the current season is therefore 33 million tons, as compared with 32·4 millions in 1919, and an average of 31·8 millions during the previous five years. These data all include estimates of old stocks at the beginning of July, and indicate that the North American supply of wheat for 1920-21 is apparently much as usual. Farm preparations for the winter wheat crop of 1921 are progressing favourably.

VICTORIA AND ALBERT MUSEUM.—A number of interesting pieces of English furniture acquired by purchase and gift have recently been added to the collections of the Victoria and Albert Museum, and are exhibited in the Galleries of the Department of Woodwork. The most valuable purchase is that of an English side-table with marble top of the date 1730-1740, of walnut wood enriched with carving of the finest quality—a distinguished piece belonging to a type hitherto unrepresented in the Museum. Another important purchase is that of an English arm-chair of the first half of the sixteenth century, carved with linenfold panels and ornament of the Renaissance style. Among gifts should be specially noted a pair of richly carved chairs of the Queen Anne period, given by Sir Paul Makins. Of much interest to visitors, further, will be the Powell Collection of Dolls and Dolls' Furniture presented by Mr. Harry J. Powell, consisting of numerous costume dolls dressed by members of the donor's family between 1754 and 1853, with an interesting collection of models of contemporary furniture and specimens of Leeds pottery.

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FRIDAY, OCTOBER 29, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICE.

INDIAN AND COLONIAL SECTIONS.

The Council have appointed Sir William S. Meyer, G.C.I.E., K.C.S.I., High Commissioner for India, a member of the Indian Section Committee; and the Hon. Sir James Allen, K.C.B., M.A., High Commissioner for New Zealand, a member of the Colonial Section Committee.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

AIRCRAFT PHOTOGRAPHY IN WAR AND PEACE.

By Captain H. Hamshaw Thomas, M.B.E., M.A., F.G.S.

Late Royal Air Force.

Lecture III.—Delivered February 2nd, 1920.

AEROPLANE PHOTOGRAPHY IN TIME OF PEACE.

Although aerial photography has been chiefly developed for military purposes, it can be applied in times of peace for many civil purposes. The chief of these is the production of maps and plans, and the carrying out of reconnaissance surveys in little known regions.

In the first place, we may still regard the air photograph merely as a source of intelligence, and use the aeroplane provided with a camera as a means of exploring countries which are little known and which have not been previously studied and mapped. There are many regions in Africa and Asia about which little is known, and photographs taken from aeroplanes flying over some of them have already increased our store of geographical knowledge by showing the nature of the country, its contours, vegetation, etc. For work of this nature oblique photographs taken without special precautions are quite valuable, and suffice to convey the information sought, when no attempt at map-making is contemplated. It is impossible for an observer, when flying over new country, to take in, remember and appreciate more than the salient features of the ground, while the camera, which misses little or nothing except colour, records all the details and is an essential adjunct to aeroplane exploration.

I have given elsewhere a few examples of the value of aeroplane photographs for scientific purposes.* They are especially useful in the domain of physical geography and geology in connection with the investigation of river development, erosion phenomena, and the main features of geological structure. The photography of the basin of the River Jordan has revealed many points of interest in its history. The recent changes in its course are often indicated; the terraces formed during past centuries as it has gradually deepened and altered the river bed, the deposits formed in the old lake which once filled the Jordan Valley, the water courses which in former ages drained into the valley but are now dry, are all distinguishable. Again, the connection which existed between the Jordan Valley and the drainage of Central Syria has been indicated, and the gorge through which the rivers from the Lebanon formerly flowed into the Jordan Valley has been disclosed.

The distribution of vegetation is often very clearly shown in air photographs, the extent and distribution of woodlands is brought out, and several types of woodland can be distinguished by their characteristic appearances. In the same way, several different types of agricultural crops can be distinguished, and areas under cultivation can be readily ascertained. Experiments were made during the spring of 1919 in India, with a view to testing the utility of aeroplane photography in crop surveys, and the results obtained have, I am informed, given very great promise, and disclosed

* Nature, vol. 105, p. 457, 1920.

the fact that by this means the exact area under cultivation with certain crops can be very rapidly estimated.

Archæologists may sometimes be greatly assisted by air photographs which often, in the case of ruined buildings and sites partially overgrown by vegetation, display the plans and arrangement of buildings, in a way which it is impossible to see by observations made on the ground. In the case of the ninth century ruins of the city of Samarra in Mesopotamia, the views taken from above heaps of earth and rubble, which were apparently formless when seen from the ground, gave the outlines and plans of streets and buildings in a most striking manner.*

But there is quite a different aspect of aerial photography for civil purposes, which is the use of air photos for the construction of maps and plans. This was not a new idea, for some work had been done before the war in France, Austria, and Russia, with photographs taken from balloons; but the conditions under which aeroplanes had to work were so different that entirely new systems were needed. During the war a good deal of mapping work was carried out, but the conditions and requirements on the different fronts were not the same, and consequently several slightly different systems of work were evolved. On the Western front, the work of obtaining suitable photographs was one of the most difficult and dangerous tasks which the airman was called upon to perform; but the map compiler had much information and material from previous surveys and from cadastral plans to help him to make the utmost use of the photographs. In the Eastern theatres, on the other hand, it was possible to take photographs of exactly the kind needed with comparative ease, but here the map compiler had the most meagre information from previous surveys.

In order to compile a map of a large tract of country, two distinct types of work have to be done. In the first place, the exact positions of a number of conspicuous points have to be fixed geographically with the greatest possible accuracy (trigonometrical survey), and then topographical details, such as river, hill and valley shapes, have to be drawn in their correct positions round the points whose positions have been first established (topographical survey). The aeroplane photograph can, at present, do little or nothing to help in the first process, but is very valuable in the second stage of the work, for pictures of large areas of country can be obtained very easily in a short time. The photograph itself cannot be regarded as a map, and it is not correct to speak of an assemblage of photographic prints as a photographic map, but over a small area the photograph may be regarded as a plan of the ground by means of which the details can be measured up and, after applying the necessary corrections, can be drawn in on the final true map.

A photograph of the ground is a representation which bears a mathematical relation to the original surface photographed. If all the optical constants are known, such as the distance of the camera from the ground, the focal length of the lens, the angle between the plane of the plate and the plane of the ground, etc., then by measuring the photograph we can draw a true plan of the ground depicted. Some of these constants may be easily found, others may be more difficult to determine, but time will not allow me to deal with them in detail. If, however, the picture represents the ground in a uniform manner, and has the same scale in all parts, and if we can find out what is the relation of the sizes of the objects shown in the picture to their true sizes on the ground, we can at once proceed to draw our topographical detail on the map.

We know that if we use a lens which is free from distortion, we can obtain a perfectly true photographic copy of a picture or plan with a copying camera, so long as the original is perfectly flat, and the sensitive plate in the camera is parallel to it. Also the size or scale of the copy will depend on the focal length of the lens used, and on its distance from the original.

If, however, the sensitive plate is not parallel to the original, the copy will not be true to scale, but one side will be more highly magnified than the other. The more the camera is tilted, the greater will be the discrepancy in scale between the two sides of the picture, and when the plate is put at right angles to the surface photographed, as in the case of a landscape taken from the ground, the objects of the foreground have a certain size, while those of the far distance have become infinitely small. The same principle applies in the case of aerial photography: if the ground is flat, and the plate in the aeroplane camera is held perfectly horizontal, then the photograph shows the ground in true plan. If, however, the plate is tilted at the moment of exposure, one side of the picture will have a larger scale than the other. It may be spoken

* Geographical Journal, vol. 53, p. 330, 1919.

of as an oblique or perspective view if the tilt is intentional, but if the tilt was unintentional and the true plan was required, the tilted view may be described as distorted.

It is by no means easy to take a photograph from an aeroplane with the plate absolutely horizontal, especially when the machine is under anti-aircraft fire, and one of the first steps was to find out methods for transferring to the map, details from a photograph which possessed a slight amount of distortion. There are several ways of doing this, the best being the method of re-photographing in such a way as to correct the distortion by reference to known points shown in the view. This process, however, can only be used when four, or in certain cases three points which are shown on the photograph have been previously fixed by reference to ground survey. In the Eastern theatres of war it was very seldom that this condition was fulfilled, and it was necessary therefore to adopt an entirely different method of work; in fact, it often happened that the only points fixed by ground survey were four or more miles apart, and might be only shown in one print of a series of three or four.

The work done on the Palestine front, where about 2,000 square miles of country was photographed to supply the topographical detail for a new series of military maps, probably shows one way along which aerial photo surveying is likely to develop in times of peace. Here the chief effort was concentrated, not on the methods of correcting distortion, but on the means of avoiding it. If the plate can be maintained in a position not more than one or two degrees away from the horizontal, distortion will be absent, or so small that it is negligible, and still better accuracy may be obtained by taking photographs with liberal overlaps and discarding the edges near which the inaccuracies in scale become more pronounced. The methods used in this field have been described in a recent number of the Geographical Journal,* and need not be here repeated.

Another method of getting over the difficulty of the tilted plate has been employed. This consists in the attempt to measure the angle of tilt at the moment of exposure, and many German cameras were provided with a small optical apparatus actuated by gravity for ascertaining the tilt in the two directions at right angles to the plate's surface. The application of this idea makes it possible to use oblique photographs as well as vertical ones for map construction. The oblique view usually embraces a much more extended area than the vertical photo, but the plotting on the map of topographical detail from it is at present a somewhat laborious process. We must notice, however, that the horizontal plate method is inapplicable in mountainous country, and it is often in country of this description that aerial photography will be most valuable as a survey method in the future. It seems probable, therefore, that the method of working from perspective photographs is one which will amply repay for its study and investigation. Work has been already done on these lines, for it was from oblique rather than vertical photographs that the first balloon surveyed maps were made, and more recently investigators such as Burchall* have returned to this study.

The geometrical and optical conditions of the problem are well known, but the present need lies first in devising a method which will be easy to work, rapid and accurate, and secondly, in perfecting the apparatus for the purpose.

The application of the method of oblique photography also holds out the possibility of extending a survey area away from the trigonometrically fixed base. Assuming that certain points shown in the photograph have been fixed by ground survey, it may be possible to determine accurately the positions of other points shown in the view, and by making fresh exposures to include the spots thus treated, it is, perhaps, possible to determine the position of a third set of points at a greater distance. No practical work has yet been done in England on these lines, but they are probably applicable to the survey of mountain regions, following on the lines of the photogrammetrical methods elaborated in France and America.

It is in country which is difficult of access that aeroplane surveys are most likely to be valuable, and photography from airships must also be taken into account. In some parts of the earth which have not yet been mapped, the main difficulty is that of progression; in parts of the desert mountains of Sinai, as in other similar localities, the ground is so steep and so broken that a party working on the ground could at times do little more than a mile or two per day. In forest regions, work by the ordinary methods of ground survey is rendered practically impossible by the trees and undergrowth, and map-making is very difficult if not impossible. In waterless desert regions again, the maintenance of a survey party, for a period long

* Geographical Journal, May, 1920, p. 349.

* British Journal of Photography, vol. 67, p. 434, 1920.

enough to allow any extended area to be covered, is rendered almost impossible owing to the water difficulties. In all such the aeroplane or airship, which can travel a hundred or more miles from its base and photograph the surrounding country, may possibly be able to achieve surveys of the most valuable description. At present, however, such work must be combined with ground observation whatever may be possible in the future, but a rapid traverse of the country by the easiest route may be sufficient to provide a chain of fixed points on which the photographic work may be fitted. We are as yet only on the outskirts of the problem, and there are many methods by which the range of usefulness of aerial survey may be extended. For example, in a clear sky an aeroplane or airship may be followed by observers through high-powered theodolites for a very considerable distance, and by means of two instruments at either end of a measured base and a wireless apparatus, the position of the machine at any moment may be determined with accuracy. Consequently also the positions of those places on the ground which are being photographed at the times when the observations are made, may also be ascertained. It is difficult to say to what distance work may be extended by this method after suitable apparatus has been constructed including, perhaps, the use of the principle of the heliograph.

We are also only on the threshold of the system of using to their fullest extent the principles of stereoscopy for metrical purposes in aerial surveying. The geometry of the subject has been very fully studied and worked out by M. Clerc,* but the practical and quantitative value of the methods is still awaiting further experiment and investigation.

The employment of aerial survey for mapping the congested cities of the East was successfully introduced during the war, and further experiments conducted more recently bear out the contention which has been made for this work. While city surveys on the ground require in many places an immense expenditure of time and money, they can be carried out from the air in a day or two at a trifling cost. Even if an aeroplane has to be brought up specially for the work, the whole cost of producing a map good enough for police and administrative purposes, is probably not more than a tenth of what a similar map would cost to produce by ground survey, and it can be subsequently improved with comparatively unskilled labour by the usual methods, if a complete ownership map is required.

* Applications de la Photographie Aérienne, p. 53, Paris, 1920.

The preparation and revision of cadastral plans is another activity in which aerial survey promises to play a useful part.

The fact that in an aerial photograph of the sea, lakes, or rivers, there are clearly shown shallows, sand-banks, and rocks near the surface, has suggested the employment of aeroplanes or seaplanes for the charting of harbours or navigable channels. In regions such as the River Hoogly, where changes in the channels are frequent and form a deadly menace to navigation, the use of the air-camera reconnaissance is almost certain to become, in the course of time, an important factor in adding safety to navigation and assisting the development of trade. There are many rivers whose courses change or whose sandbanks alter from time to time, and we now have a means by which such changes may be watched and recorded for the benefit of civilisation, and which will assist man in his contest with the elements. Already our methods have been employed for hydrographic work, and so are assisting the world's navigators.

Enough has been said to indicate the utility of aerial photography in the service of man in times of peace. I have left out of account work of more or less private or limited interest, such as the photography of buildings in our own country, or of estates or golf courses. These may in time come to be regarded as part of the ordinary amenities of civilisation, and air photos may take an officially recognised place as records of the extent and position of grounds or buildings in commercial or legal transactions. The work of carrying out this class of photography has already been commenced by one of our enterprising aviation firms, and the demand which has been experienced shows that a useful result is being achieved.

At the present period the development of the science for civil purposes may be slow, but when the conditions of aviation become stabilised we are certain to see important developments. Later, also, we may expect that countries which are maintaining air forces with a view to military eventualities, will begin to employ machines for peace purposes such as air-surveys, which are of public importance. Thus the arts of war may be turned to account for the benefit of civilisation and the cause of peace.

LIST OF SOME PUBLICATIONS DEALING WITH AERIAL PHOTOGRAPHY.

Clerc, L. P.—Les Applications de la Photographie Aérienne. Paris, 1920.

Ives, H. E.—Airplane Photography. Philadelphia, 1919.

Bagley, J. W.—The Use of the Panoramic Camera in Topographical Surveying, with Notes on the Application of Photogrammetry to Aerial Surveys. Washington, U.S. Geol. Survey, Bull. No. 657, 1917.

Burchall, P. R.—A Method of Employing Oblique Aerial Photography for the Triangulation of Unmapped Territory. Brit. Journ. Photography, vol. 67, p. 434, 1920.

Burchall, P. R.—An Elementary Survey of the Present Position of Aerial Photogrammetry, Brit. Journ. Photography, vol. 66, p. 695, 1919.

Clerc, L. P.—Photographic Correction of Negatives taken Obliquely. Brit. Journ. Photography, vol. 66, pp. 396, 411, 428, 440.

Clerc, L. P.—Calculations in Aerial Photography. Brit. Journ. Photography, vol. 66, p. 275, 1919.

Houard, G.—La Cartographic Aérienne. La Science et La Vie, No. 33, p. 37, 1917.

Laws, V. F.—Aerial Cameras. Photographic Journal, vol. 59, p. 192, 1919.

MacLeod, M. N.—Mapping from Aeroplane Photographs. Geographical Journal, vol. 53, p. 382, 1919.

Hamshaw Thomas, H.—Geographical Reconnaissance by Aeroplane Photography, etc. Geographical Journal, vol. 54, p. 349, 1920.

Hamshaw Thomas, H.—Aircraft Photography in the Service of Science. Nature, vol. 105, p. 457, 1920.

Appleton, W. B.—Improvements in Lenses for Aerial Photography. Royal Photographic Society, 1919. Brit. Journ. Photography, vol. 66, p. 243.

For works on balloon photography consult bibliography in the work by L. P. Clerc, mentioned at the head of this list.

Many volumes have been published upon the interpretation of aeroplane photographs during the war, but these are confidential publications not available to the general public.

COAL AS A FUTURE SOURCE OF OIL SUPPLY.

Sir Arthur Duckham, K.C.B., M.Inst.C.E., recently read a paper on the above subject at a meeting of the Institution of Petroleum Technologists. He submitted that the industrial future of this country lies in the conversion of coal at the pit's mouth into liquid and gaseous fuels. Liquid fuel, he said, will be recognised as the medium for providing energy for all transport on land, sea, or air, with the exception of electrical transport for congested areas, while gaseous fuel will be used direct for the great majority of heating purposes and for the generation of electricity, either by means of steam plants or engines.

The submarine has become so great a danger that should another war come, it is possible this island might indeed be isolated and cut off from all outside sources of oil supply. It is therefore essential for national as well as economic necessity to develop supplies of oil fuel at home.

The Government, he maintained, instead of appointing Electrical Commissioners should have appointed Heat, Power, and Light Commissioners, to foster fuel conservation on general lines, and not think only in terms of electricity. He trusted that the duties of the Electrical Commissioners would be extended by the Government to embrace these other duties. He reviewed the various processes for the heat treatment of coal, and in conclusion formulated a system of manufacture to meet the demand for liquid and gaseous fuels for practically all purposes. The total gasification of coal is essential, preferably in one vessel. The plant must be economical in first cost, and low in labour charges, but above all the maximum amount of the volatiles in the coal must be recovered in a liquid form, being distilled over at such temperatures and in such a manner that a minimum of cracking takes place. The gas afterwards should be stripped of all saturated hydrocarbons and supplied to the consumer constant in heat value and specific gravity.

Further, special care must be taken to preserve the ammonia obtained from the nitrogen in the coal. The plant must be designed to work with any coal, but he does not believe it possible to design a plant of this type capable of working greatly varying coal over short periods, or of working coal containing, say, over 60 to 70 per cent. of fines.

The form of plant he suggests is one or more vertical retorts superimposed over a water gas producer, the retorts being so constructed and heated that even difficult coals like Durham will work through without undue attention, and the coal be fully converted into coke before entering the producer. The producer should be built and worked to obviate the formation of hard clinker, with mechanical grates for the continuous and clean removal of the ash. Automatic compensating devices would have to be included for the regulation of the pressure in the retorts during the run and blow periods. Such a plant, fitted with recuperators and waste heat boilers, would have a very efficient heat cycle, which would undoubtedly result in a large conservation of fuel. If the major portion of the coal used in this country were first treated by such a process, the fuel oil position would be made much easier, as greatly increased supplies would be forthcoming; the demand would accordingly greatly increase, and, as far as he can calculate, gas could be distributed to consumers at from one and a half times to twice the amount it would cost per heat unit to

supply as solid fuel. The saving in labour and transport, the cleanliness, and the efficiency of utilisation would far more than compensate for this increased charge.

COCONUT PRODUCTION IN TROPICAL AMERICA.

Coconuts have long been considered one of the most valuable products of the Tropics. The palm grows wild and is utilised in many ways by the natives of the tropical countries. The meat of the nut, eaten raw or cooked, forms an important article of food, and the liquid contained in the centre of the nut a most refreshing drink; the sap from the unopened flower buds is also used as a drink and is highly intoxicating if allowed to ferment for some time; the husk of the nut is used for fuel, and its fibres to make rope, matting, and brushes: the shell of the nut is used for fuel, for drinking cups, and various household utensils; the leaves and the wood of the palm are utilised for mats, thatching, and timber for huts.

Coconut products are exported in three forms, the whole nuts, the dried meat or copra, and coconut oil. Coconut oil is used in various products such as soap and candles, in addition to butter and lard substitutes. Copra is pressed to extract the oil, and the remaining product, either as copra cake or ground into copra meal, serves for cattle and chicken feed and for fertiliser. Fresh coconuts are converted into copra or the fresh meat is used in confectionery and pastry.

The bulk of these commercial coconut products comes from the Tropics of the Far East, notably from the Philippines, India, and Ceylon, the Malay Peninsula, and islands near it. The total quantity exported from tropical America is small compared with that exported from the Far East. With a few exceptions, little scientific cultivation has been attempted in the West Indies, Central America, or along the north coast of South America. There are but few large plantations; comparatively little copra is manufactured except that necessary to supply local needs; and the bulk of the exports consists of whole nuts which have been gathered by the natives in the wild groves fringing the coasts.

The British Government has encouraged coconut cultivation in its tropical colonies, including Trinidad, Tobago, and Jamaica, and several large American companies owning banana plantations in Central America and the West Indies are experimenting with coconut cultivation. Coconuts, scientifically grown on a large scale, are said to be one of the most profitable of tropical crops, but the large initial expenditure of capital necessary and the long wait for returns on this expenditure have prohibited any extensive development by native planters with limited capital.

From an interesting Memorandum on Coconuts in Tropical America, prepared by the Latin-American Division of the United States Bureau of Foreign and Domestic Commerce, it appears that Trinidad, Tobago and Jamaica are the only West Indian islands where coconut raising has become an important industry, although Hayti, Cuba and Porto Rico also export small quantities of coconuts and copra. Coconuts grow on some of the smaller islands, but are not exported. During 1917 the total exports of coconuts from Trinidad numbered 17,355,712, valued at about £93,000, of which 16,595,282 nuts were produced locally and 760,430 were produced outside the island, chiefly in Venezuela. Most of these nuts were shipped to the United States. During the same year the exports of copra amounted to 7,201,448 lb., valued at about £107,000, less than half of which was shipped to the United States. All the copra exported from Trinidad in 1917 was locally produced. The constant planting of new trees which is going on in the island ensures increased exports within a few years.

Trinidad has some 27,000 acres planted in coconuts with probably two-thirds of the trees now bearing.

Tobago, about one-fourth the size of Trinidad, has about 9,000 acres planted in coconuts but only a few of the trees are bearing. The two chief coconut districts of Trinidad are the Cedros district, which covers about 9,640 acres planted to coconuts, of which some 7,000 are now producing nuts, and the Mayaro district which includes about 7,500 acres of coconut trees all old enough to bear.

The Cedros district includes the plantations on the narrow peninsula situated at the extreme south-western part of the island, and also plantations stretching from this peninsula along the coast of the Gulf of Paria almost to La Brea near the famous asphalt lake. The present annual production of this district is now about 21,000,000 nuts, and probably will be doubled within the next eight or ten years. About 50 per cent. of the nuts produced are selects, 30 per cent. culls, and 20 per cent. rejects. The selects and culls are usually exported as whole nuts and the rejects manufactured into copra. Nearly four-fifths of the nuts are raised on large plantations owned by English companies or planters of French and English extraction. The cost of working these large estates is considerably less per acre than that of working the small holdings. The Mayaro district consists of a narrow strip of land on the southern part of the eastern coast of the island and is about 17 miles in length and ½ mile in width. About 12,000,000 nuts are produced annually in this district. The nuts are smaller than those raised in the Cedros district and about 80 per cent. of them are rejects.

In 1916 and again in 1917 Jamaica exported some 27,000,000 coconuts, the larger part of both crops going to the United States. These nuts were shipped in bags containing 100 or 150 nuts each, and the value of the entire amount exported in 1917 was approximately £145,000. About 35,000 acres are covered with coconut palms, and there is plenty of agricultural labour obtainable.

During 1917, Cuba exported 3,393,000 whole

coconuts to the United States and 5,432 kilos of copra. According to the Cuban Department of Agriculture, coconut palms are found scattered all over the island, but they are only grown for commercial purposes around Baracoa, which is situated on the northern shore of the island at the extreme eastern end. The average annual production of this district was estimated to be approximately 8,000,000 nuts during the three-year period ending in December, 1917. Coconuts are also found in the southern part of the Isle of Pines. Bud-rot disease, which became prevalent in 1904, has reduced the production of the Baracoa district nearly 50 per cent. and, as no effective remedy has yet been discovered, bids fair to reduce it still further. The spread of this disease, unfavourable soil conditions, and the little care accorded to commercial plantations have united to make coconut culture an unprofitable business in the island.

In Porto Rico the coconut industry has shown a steady increase. The exports amounted to £114,000 during the fiscal year 1918. In 1916 over 6,000 acres were covered with coconuts, and additional plantings were being made. Practically no copra is manufactured in Porto Rico, because of the large local demand for the ripe whole nuts. The Porto Rican nuts produce an exceptionally good quality of coir fibre, about 300 lb. of fibre being obtained from 1,000 nuts.

During the calendar year 1917 the Dominican Republic exported 422,330 kilos. of coconuts and 167,000 kilos. of copra. The Republic of Haiti only exported 60,456 kilos. of coconuts during the year ended the 30th September, 1917. Practically all nuts exported from the Dominican Republic are shipped from the port of Samana and are produced around Samana Bay. Although there are no large estates, the cultivation being done on a small scale, there are estimated to be approximately 9,000 acres planted to coconuts in this region. Bud-rot has done considerable damage to the coconut palms in the last few years. The nuts are usually shipped in jute sacks containing 100 nuts each. Coconuts grow all around the coast of Haiti, and at many points in the interior, but regular plantings are few in number and widely scattered. The nuts are said to be most abundant in the vicinity of Anglais Bay on the south side of the Tiburon Peninsula.

Panama exported to the United States in 1918 coconuts to the number of 19,758,949, valued at about £176,000. Of this quantity, some 6,000,000 were re-exports from the island of San Andres, a possession of Colombia, about 250 miles north-west of Colon. Practically all coconuts are exported from Panama in the shell, prices being quoted per 1,000 nuts. The nuts weigh about 1,650 lb. to 1,000 nuts.

The coconut crop of Panama ranks next to its banana crop, and is steadily increasing in importance as new areas begin to bear; banana plantations which have suffered from the blight are being converted into coconut plantations. The famous San Blas nuts of Panama are gathered by the San Blas Indians from territory which they control, a stretch of land about 120 miles long bordering the Atlantic, and some 365 small islands near the coast. This district alone has about 300,000 trees. These nuts and those grown on the Pacific coast of the Panama known as the "choco" nuts are among the finest in the world. The nuts are large, the meat is very sweet, rich, and white, and is easily removed from the shell. Coconut raising and gathering are also carried on by natives and Spaniards on the Palenque coast some 30 miles north-east of Colon, and, recently, coconut cultivation has been started on the Pacific coast by Americans.

During the year 1916-17, Honduras exported 10,533,572 whole coconuts (most of them through the port of Roatan), 149,772 lb. of copra, and 4,442 lb. of cohune nuts. Most of the whole nuts and all the copra and cohune nuts were shipped to the United States. According to the 1916 statistics of Honduras, there are 2,252 acres in the Republic covered with coconut palms in addition to the large groves on the Bay Islands just off the north coast. On a well-kept plantation the average annual yield is about 70 nuts per tree, and the nuts weigh about 150 lb. per 100 nuts. Two small copra factories have been established to utilise the rejects, one factory at Roatan on the Bay Islands, and the other at Puerto Cortez on the north coast.

Coconuts are not among the principal exports of Costa Rica. However, there are 750 acres of coconuts under cultivation on the eastern coast, and there are scattered groves on the western coast. Like the banana tree, the coconut palm here is attacked by insect pests, which may eventually destroy the tree entirely. One of the greatest pests is a large beetle called the chinoceros beetle, which gets into the crown of the tree and eats the fresh shoots until the tree loses its vitality and dies.

During 1917 Nicaragua exported 1,097,423 coconuts, most of which went to the United States. An American concern has purchased large plantations stretching for 35 miles along the coast between Greytown Harbour and Punta Roca. It has 61,000 new trees, and 30,000 good bearing trees. The monthly production of nuts is said to be about 35,000. The Corn Islands off the east coast of Nicaragua contain dense groves of coconut trees, from which it is reported 400,000 nuts could be exported monthly if sufficient shipping facilities were assured. Large ships do not visit the Corn Islands owing to lack of harbour facilities, and the nuts are shipped, therefore, in small schooners to Colon, whence they are re-exported.

Bananas have been found to be a more profitable crop in Guatemala than coconuts, and consequently the cultivation of the latter has decreased during recent years. In 1915, the last year for which official statistics are available, 8,175 bundles weighing 50 lb. each were exported from Puerto Barrios to the United States. The trees thrive in Guatemala and respond well to care and cultivation. In the few coconut plantations maintained, the average annual yield is 200 nuts per tree.

In 1914, the latest year for which figures are available, British Honduras exported 6,411,477 coconuts, of which over 6,000,000 were shipped to the United States. In addition, the colony sent 140 tons of cohune nuts to the United Kingdom and 92 bags to the United States. A small amount of sun-dried copra has been produced in Belize since 1915. Little information is available concerning the cultivation or gathering of coconuts in British Honduras. They grow wild for 50 miles up the Belize River Valley.

It will be noticed that cohune nuts appear among the exports from Honduras and British Honduras. These nuts are similar to coconuts but are smaller, and have a very hard shell. They are a native product of Central America and Mexico, and have been found to yield an edible oil much like coconut oil, and of equally good quality. They have not yet been exported to any great extent, but if prices were sufficiently high could be collected in considerable quantities.

In British Honduras alone there are estimated to be 2,000,000 acres covered with cohune trees; but until the war demand for charcoal made from coconut and cohune-nut shells, no effort had been made to export cohune nuts. The trees occur in dense groves on the so-called cohune ridges where the soil is fertile and the drainage good. Large numbers are also found on the "broken ridges" where the best stands of mahogany occur, but here they are dwarfed by the dense growth of other vegetation, and only an occasional tree which has a good supply of light and air bears fruit. About 25 miles inland in the Belize Valley they begin to replace the coconut trees, and about 75 miles up the river the coconuts disappear and cohunes become very abundant. The centre of the best cohune district is 75 to 100 miles from the sea. Farther inland than this the trees begin to decrease gradually, although they are found in large numbers in adjoining parts of Mexico and Guatemala. At other points in British Honduras, such as Stann Creek and the New River, the cohune is found much nearer the sea. From the cohune district as a whole, it is estimated that there is an annual production of 25 tons per 1,000 acres, or 50,000 tons per year. It is impossible to utilise more than a fourth for commercial purposes because of the inaccessibility of many of the groves, the lack of transportation facilities, the large overhead cost of gathering the nuts, and the shortage of labour.

In Honduras the nuts are found upon the low lands toward the eastern portion of the north coast. In the Aguan River Valley there is a single field 1 to 12 miles wide and 60 to 70 miles long. Persons familiar with the industry who have been over this field estimate that an equipped force of 500 men could collect 10,000 tons of nuts from this tract alone. There is no railway up this valley at the present time, but there are good prospects of one reaching the valley in the near future. The cohune nut in Honduras varies in size, measuring from 1 to 2 inches in diameter and from 1½ to 3 inches in length.

Cohune nuts are found growing wild everywhere in the swamp sections of the Nicaraguan coast. The quantity is not known, except that considerable areas of swamp contain them. It is estimated that the cost of gathering the nuts would be about £4 a ton.

Cohune nuts grow up to an altitude of 1,500 feet on the south shore of Guatemala and to an altitude of 500 feet on the north shore. It is estimated that on the south coast there is an annual production of at least 2,000 tons of nuts, which could be shipped over the International Railway to the ports of Ocos, Champerico, and San José. On the north coast the nuts occur in three separate sections—in the valleys of the Sarstoon, the Dulce, and the Motagua Rivers. The Sarsoon Valley is inaccessible, and hence it is impossible to get the nuts out; the valley of the Dulce contains what is perhaps the richest cohune tract in Guatemala. but as yet it is practically unexploited; the Motagua Valley is tapped by the International Railway and branch lines of the United Fruit Company. This last district was opened up to some extent during the war.

To turn to South American countries producing coconuts the chief would appear to be Brazil, Colombia, British Guiana, Venezuela, and Ecuador. In 1917 Brazil exported 2,243,000 coconuts, 15,680 kilos of copra, and 72,230 kilos of coconut oil. Scattered groves of coconut palms are found along the Brazilian coast from the northern boundary south to Bahia and up the valley of the Amazon as far as Manaos, but, of course, rubber gathering is the chief industry of the tropical jungles of the Amazon Valley.

At present the productive coconut belt of Brazil is included in the States of Parahyba, Pernambuco, Alagoas, Sergipe, and Bahia, and the exports are shipped mainly from Cabedello, Pernambuco, and Maceio. About three-fourths of the coconut trees of the district are centred around the ports of Cabedello and Maceio. The groves fringing the coast of this district vary in size from a few hundred trees to 40,000, the total number of bearing trees approximating 1,250,000, and the total production of nuts 50,000,000. The average size of these nuts compares well with the size of the products of other tropical countries, 5,000 nuts being required to produce a ton of copra. Even in the coconut belt very little copra is made, no seed selection is practised, trees are crowded close together, and the vitality of the trees is lowered by continued picking of the green nuts, of which large quantities are consumed in the country. Coconut raising might become very profitable if modern methods of cultivation were employed. Disease and pests are almost unknown, labour is cheap, and the local markets for the by-products are good.

During 1915, the last year for which official statistics are available, Colombia exported 74,075 kilos of coconuts, all to the United States.

No definite information is available concerning coconut cultivation or gathering in Colombia, but the American Consuls at Santa Marta and Barranquilla report that there are only a few scattered groves in their respective districts. Apparently exports from the small islands of San Andres and Providencia are not included in the official Colombian statistics. Coconuts form the chief source of wealth of these islands, which are said to export between 3,000,000 and 6,000,000 nuts annually. They are shipped in sailing vessels, either direct to the United States or to Colon for re-export.

In addition to the coconuts exported in 1915, a few kilos of corozo or cohune nuts were shipped from Barranquilla. These nuts are reported to grow in many parts of tropical Colombia in considerable quantities, but are not gathered at the present time.

British Guiana exported 1,911,404 coconuts in 1917 and 168,784 lb. of copra. These commodities were shipped to the United States, Canada, and England. British Guiana, not being subjected to severe hurricanes, is particularly suited to raising coconuts, and increased attention has been given to this industry in the last few years. Fully 17,000 acres of palms have been planted recently.

During 1917, 491,750 kilos of coconuts and 41,332 kilos of copra were shipped from Venezuelan ports and, in addition, many of the coconuts produced on the Venezuelan side of the Gulf of Paria were exported from Trinidad. Copra made in Venezuela is practically all sun-dried.

Coconuts are produced on various parts of the coast of Venezuela. The district around the Gulf of Paria is said to produce 2,500,000 nuts per year, of which 1,800,000 to 2,000,000 are raised on one large estate containing 60,000 trees. Just west of the Gulf of Paria, stretching from Carupano to Cumana but centering around the small Gulf of Cariaco, is another coconut district which is said to produce about 3,000,000 nuts annually. The towns of Guanta and Cumana in this district have a considerable oil and soap-making industry.

No recent Mexican statistics are available which give exports of coconuts, but United States import statistics show a very small amount of coconut products imported from Mexico during the fiscal year 1918. The wild coconut groves which fringe both the Atlantic and Pacific coasts of the country have been injured during the last few years by soldiers and bandits, and the disturbed condition of the country has prevented cultivation or gathering of the nuts for commercial purposes. Mexico affords a good field for coconut cultivation under normal conditions.

In addition to the wild coconut groves on the coasts there are groves of "coquitos" (little coconuts). These nuts are gathered in the winter season and used by the local soap factories, but are not exported.

THE SEAL OIL INDUSTRY.*

The sealing industry is actively pursued in the North Atlantic, in Alaskan and Siberian waters, and in the Caspian. Seals are valued for their furs, skins, and oil. The oil is chiefly obtainable from the hair seals. These are of numerous species. According to Dr. Charles H. Townsend, a leading American authority on seals, the most important from the oil standpoint is the Newfoundland harp seal (*Phoca groenlandica*), which has a very wide distribution, and is probably the most abundant of any species of seal. A small number of hooded seals (*Cystophora cristata*) is included in the annual catch. It is taken upon the Arctic ice from Newfoundland to Baffin Bay, and from Greenland across to the perpetual ice fields north of Europe. The seals are taken in their breeding places on the drifting ice, where the crews land and kill the younger animals by clubbing. More than ninety per cent. of the catch is made up of young seals, taken before they are three weeks old, when they are large enough to enter the water. Owing to the fact that this species is taken upon the ice fields, and that the latter are at times greatly disturbed by storms, the catch of seals is subjected to certain natural limitations. After the more effective steamers had replaced sailing vessels it became necessary to place restrictions upon the slaughter of the animals. At the present time the season begins on March 16, and the period during which seals are taken upon the ice lasts little longer than a month.

Caspian Seal.

Although seal fisheries are naturally associated with the great oceans, an important sealing industry is that of the Caspian Sea, which has long been carried on in this inland brackish lake. The seal which is the basis of this fishery (*Phoca caspica*) is a species peculiar to the locality, which probably found its way to its present habitat in very ancient times, when the Caspian was connected with other seas. About thirty years ago the average annual seal catch in the Caspian Sea was slightly over 100,000, worth in skins and oil $350,000. There are no recent data at hand.

Lake Baikal Seal.

Another seal (*Phoca sibirica*), remarkable chiefly for its habitat, is that found in Lake Baikal in the heart of Siberia. Here, however, the range of seals is restricted to a body of water only 400 miles long, and their numbers are too small to be of more than local importance.

West Indian Seal.

The West-Indian seal (*Monachus tropicalis*) was formerly abundant in the Caribean Sea and the Gulf of Mexico, extending north-eastward to the Florida keys and the Bahama Islands. This species, valuable for its oil, was practically exterminated over one hundred years ago. A few individuals of

* Extracted from an article by Bertrand A. Goodwin, in *The Street*, New York.

the race still linger on the Triangle Islands in the Gulf of Campeachy, where occasional specimens are procured for museum purposes. A seal of this species lived five and a half years in the New York Aquarium.

ANTARCTIC SEALS.

The various species of Antarctic fur seals (*Genus Arctocephalus*) were found about the southern shores and islands of South Africa, Australia, New Zealand, and the islands of the Antarctic generally. About the close of the eighteenth century a traffic sprang up in the skins of fur seals, and as the result of the many voyages made to those distant regions enormous numbers of fur seals were taken. They exist to-day as mere remnants of the great herds that were once found in those parts. By 1830 the supply of fur seals in the southern seas was nearly exhausted. In this sealing no discrimination was made in the character of the seals taken; all animals whose skins were of any value were slaughtered, and the newly-born young, usually left on the killing grounds, died in consequence. In the rush for seals to the Antarctic sealing grounds the markets were frequently glutted, and much of the catch wasted.

There are few parts of the world where seals of some species do not occur. All seals breed on land or on ice floes, and return, after their migration, to their accustomed breeding places with great persistence. They can seldom be driven entirely away, stupidly lingering until brought near to the point of extermination. So certain are the seals of returning to their breeding grounds, that the re-establishment of the different species soon follows the protection of these places. The safe-guarding of depleted sealing grounds would, in fact, be a good business proposition, even at this late day, if they could be protected under the authority of the various governments laying claim to such lands.

SOUTH AFRICAN SEAL.

The South African fur seal (*Arctocephalus delalandi*), frequenting small islands off the west coasts of South Africa, became very rare from indiscriminate sealing. It has, during very recent years, been protected by the Government of Cape Colony.

GALAPAGOS SEAL.

One resort of the genus *Arctocephalus*, the Galapagos Islands, lying on the equator, about 800 miles west of Ecuador, furnishes a striking illustration of wasteful sealing: Fur seals (*Archocephalus philippi*) were taken from the Galapagos Islands in important numbers by early voyagers. Between 1870 and 1882 these rookeries were again visited by sealers, and as far as appears from the meagre records collected from the sealers still living, who engaged in this fishery, about 20,000 seals were taken. This is, of course, a trivial number as compared with the total catch made during that period, the records of which are not available. The later voyages to the Galapagos Islands resulted in the killing of all the seals that could be found.

GUADELOUPE SEAL.

Another species of fur seal (*Arctocephalus townsendi*), the most northerly off-shoot of the Antarctic race of fur seals, formerly inhabited Guadeloupe and other islands off the west coast of Lower California. From the scattered records that have been found, it appears that 15,000 seals have been taken there within comparatively recent years—the earlier records are not available. During the writer's visit to Guadeloupe Island, in 1892, straggling fur seals were observed about the island, and specimens obtained which proved the species to be new to science. It is possible that there is a sufficient remnant to warrant the belief that the race could be re-established if the islands were properly protected by the Government of Mexico. The value of fur seal-skins taken in tropical or semi-tropical localities is small as compared with those from cold climates.

LOBOS SEAL.

In all the history of Antarctic sealing there is but one chapter of wise management and thought for the future; the Government of Uruguay has throughout all these years, carefully preserved the fur seal rookeries of Lobos Island, at the mouth of the La-Plata River, inhabited by *Arctocephalus australis*. These small rookeries illustrate the good resulting from the careful protection of fur seals upon their breeding grounds. Commercial sealing was carried on at Lobos Island prior to 1820. The lessees of the island, operating under the direction of the Government of Uruguay, placed upon the London market, from 1873 to 1904, 377,033 skins, or an average of over 13,000 a year, worth, in 1901, $100,000. All these were derived from a single island less than one mile in length.

OKHOTSK SEAL.

The history of Robbin Island, in the Okhotsk Sea, is especially interesting. This island is about 600 yards in length, and less than 100 yards in width, and yet incomplete records show that more than 60,000 seals have been taken there by raiders since 1870. A remnant of this herd has remained to repopulate the rookery annually, which at the present time contains little more than 1,000 seals, and is protected by the Russian Government.

The scattered fur-seal rookeries in the chain of volcanic islands stretching northward from Japan, known as the Kurils, have been destroyed by raiders during recent years. The history of the extermination of these seals, as furnished to the writer by men who engaged in the slaughter, is exceedingly interesting. Notwithstanding the fact that raids were made year after year, the scattered remnants of the herd still cling to their old breeding grounds. The incomplete records at hand show that more than 25,000 seals were taken from the Kuril Islands by raiders since 1880. These rookeries were visited by the U.S.S. Albatross in 1897, and all the rookeries were found to have been wiped out with the exception of one, upon which there were about 100 seals remaining. It is

believed that these will be protected by Japan, to which country they belong. The seal inhabiting Robbin Island and the Kuril Archipelago is now known as *Callorhinus curilensis.*

THE NEWFOUNDLAND SEAL FISHERIES.

The Newfoundland seal fisheries are to-day the most important from an economic standpoint. The seals are hunted in the ice by well-equipped sealing steamers along the north coast, in the straits of Belle Isle and Canso. This year's sealing season closed in April. Nine vessels, with crews of 1,586 men, were engaged, and the catch amounted to only 33,985 pelts, weighing 773 tons 14 cwt., valued at $159,929, as against 81,293 pelts, weighing 1,886 tons 12 cwt., valued at $278,145 for 1919, which was also a small catch as compared with those of previous years.

It is stated that the expenditure for fitting out the fleet this year was about $300,000, or nearly twice as much as it cost to fit out 22 steamers in 1900. When it is considered that only nine vessels undertook the voyage, it will be observed what strides prices have taken, particularly as to fuel and food. The loss to the Dominion resulting from the small catch is placed at $800,000. The returns of the Newfoundland sealing industry for the last ten years were:—

Year.	Number of Steamers.	Number of Seals.	Net Value of Catch. Dollars.
1911	18	304,591	494,075
1912	23	175,130	329,264
1913	19	272,965	493,845
1914	20	233,719	497,979
1915	13	47,004	93,479
1916	11	241,302	642,463
1917	12	196,228	516,756
1918	13	151,431	863,552
1919	10	81,293	278,145
1920	9	33,985	159,925

The Newfoundland seal fishery has been steadily prosecuted since 1763. In 1787 the average yield was about 5,000 seals. In 1871, 201 sailing vessels and thirteen steamers, employing 9,791 men, were engaged in the fishery. Between 1838 and 1848 the catch varied between 450,000 and 700,000 seals annually. In recent years the average has been 500,000 and 600,000 seals per annum. Only the young seals are taken. They are clubbed on the ice after they have come through the blow holes. The sealers collect the animals at intervals and deftly skin them.

THE GUTTA-PERCHA INDUSTRY.

Gutta-percha is a jungle product, obtained from trees growing wild in tropical forests. Borneo, particularly Sarawak, supplies the largest quantities, although Sumatra and the Federated Malay States furnish a certain amount. Some efforts have been made to cultivate the gutta-percha tree on estates, but they do not appear to have been successful, the reason being that the tree can only thrive in certain localities possessing the requisite humidity or rainfall and good drainage such as afforded by foothills, and these conditions occur very seldom outside certain jungle areas. So far as can be learned, writes the United States Consul-General at Singapore, there is only one district in Sarawak where gutta-percha trees have been cultivated with any success. This plantation has now been in existence about thirty years, and is only just beginning to yield supplies in marketable quantities. In this connection it may be stated that about twenty years are required before the trees are in a fair way to produce. If trees are tapped earlier, the production is small and a great risk is run of the trees withering and dying before becoming fully matured. This fact in itself would discourage the investment of any large capital in the industry, to say nothing of the extreme difficulty in successfully cultivating the trees outside their native jungles.

The milk of the gutta-percha is obtained by tapping, but in many cases the trees are cut down in order to obtain larger quantities. While this process does not actually destroy the life of the tree, inasmuch as new shoots will in time spring from the stump, it effectually cuts off the source of supply for many years. For this reason the felling of gutta-percha trees has, it is understood, been prohibited in Sarawak.

The latex is collected by natives, brought down to various villages, and bartered to the Chinese for rice, tapioca, salt, etc.

The production of gutta-percha in the various districts around Singapore is estimated to have been between 450 and 500 long tons in 1918, while in 1919 it was between 600 and 700 tons. The production is regulated according to existing values, and, should prices advance, it is anticipated that for 1920 it will amount to 800 or 900 tons. It is known that the production of gutta-percha is stimulated by further special inducements being made to the natives, who are the actual collectors. Without such inducements it is not probable that any appreciable increase in the present output of the commodity will be effected.

Another point to be carefully borne in mind with regard to the production and cost of gutta-percha is the constantly increasing area of land under rubber, coconut, and tapioca cultivation. These new estates are well regulated, and offer every inducement to the coolie type in the way of compensation and better standards of living. This class of work will, therefore, undoubtedly attract the native and coolie labour away from the jungle, and the clearing of so many tracts of land may mean the diminution of jungle areas and a consequent decrease in jungle products.

Gutta-percha to the amount of 1,469 long tons, valued at 1,468,792 dollars (U.S.), was imported into Singapore during the year 1918. Of this amount 1,372 tons, at a value of $1,358,764, were imported from the Dutch East Indies, while only 91 tons, valued at $107,431, were imported from British North Borneo, Sarawak, and the Federated Malay States.

Of gutta inferior, 5,243 tons, valued at $518,975, were imported into Singapore during the year 1918, most of which came from Dutch Borneo and Sarawak, Sumatra furnishing only 300 tons.

The following table shows the quantities, values, and countries of destination of gutta-percha and gutta inferior exported from Singapore during 1918:—

Countries of Destination.	Quantity.	Value.
GUTTA-PERCHA.	Tons.	U.S. Dollars.
United Kingdom . . .	1,596	1,556,357
Canada	138	44,895
France	113	43,909
Italy	30	11,447
Japan	33	22,755
United States	1,230	362,736
Total	3,140	2,042,099
GUTTA INFERIOR.		
United Kingdom . . .	99	9,539
Canada	71	6,365
Australia	17	1,797
Other British possessions	1	42
France	10	1,022
Japan	144	16,009
United States	834	89,959
Other foreign countries .	2	227
Total	1,178	124,960

SALT RESOURCES AND PRODUCTION OF POLAND.

Rock-salt is one of the important natural resources of the new State of Poland. The principal deposits are in Galicia, or what was formerly Austrian Poland, on the northern slopes of the Carpathian mountains, where the mines have been exploited since the twelfth century. There are also rather important deposits in the Province of Poznania (Posen), which was formerly German territory.

In the Galician district there are two Government mines, one at Wieliczka and the other at Bochnia, both of which are not far from the city of Krakow. In addition to these, there are nine other salt mines in the eastern part of Galicia. Wieliczka is known as one of the greatest salt mines in the world, embracing two square miles. Before the partition of Poland it belonged to the Polish Crown, but later it became the property of the Austrian Government and has now reverted to Poland. The estimated extent of the deposit is 21,000,000 tons of salt, and before the war its average annual production was about 110,300 metric tons, or about 60 per cent. of the total output of Galicia. One-fifth of the production was used for human consumption, and the remainder for cattle. The mine of Wieliczka is interesting as well as valuable, and the village exhibits to its visitors tables and chairs made of salt. The more important of the smaller mines are those at Bochnia, Kalusz, and Stebnick.

Although so large a proportion of the production of Wieliczka is used for cattle, the product obtained from the refineries of Eastern Galicia is almost entirely cooking salt. In 1895 the total output of the Galician salt mines was estimated at 129,500 tons, valued at about £710,000, whereas the annual production just before the outbreak of war was 141,200 metric tons, with a value of £760,000. The number of labourers engaged in the salt industry of Galicia was 3,500, and the Galician production amounted to 41·2 per cent. of the entire salt output of Austria. This exploitation was the monopoly of the Austrian Government, and owing to lax methods of production, the output fluctuated considerably. It is reported that the present condition of the Galician salt mines leaves much to be desired from a technical point of view, as a considerable part of the machinery is antiquated and of little use.

In the Province of Poznania the salt deposits have been exploited since 1870, the principal one being at Inowroclaw (Hohensalza), where the output amounted in 1906 to 55,713 tons of rock-salt and 25,556 tons of refined salt. Since that time, however, the production has decreased to some extent.

In what was formerly Russian Poland, there are salt refineries at Ciechocinek. These, however, are not of very great importance; they produced during the years immediately preceding the war some 3,000 tons annually. Formerly, this particular part of Poland imported a considerable amount of salt from Russia, but now that the rich salt deposits of Galicia are within Polish boundaries, the entire country will probably be supplied from this source.

The production of salt in Polish territories just prior to the war was thus approximately as follows: Former Austrian Poland (Galicia), 141,215 metric tons; former German Poland (Poznania), 81,269 tons; former Russian Poland, 3,007 tons; total, 225,491 tons.

There is no doubt, writes the United States Consul at Warsaw, that these Polish salt deposits are capable of much more intense exploitation and, under proper organisation, they could probably become the base for several branches of chemical industry.

Galicia also possesses at Kalusz the only potassium salt mines besides those at Stassfurt (Germany), and a company has recently been formed to exploit this deposit. These Kalusz salts are composed chiefly of kainite and sylvite. The production of kainite, which amounted in 1893 to 4,000 tons, had risen in 1913 to about 17,500 tons, valued at some £9,000. This deposit also was worked before the war by the Austrian Government, and it is hoped that now, under private initiative, it will become a considerably greater source of revenue.

OBITUARY.

Sir Arthur Charles Trevor, K.C.S.I.—Sir Arthur Trevor died suddenly of heart failure in London on October 22nd in his eightieth year. One of the sons of Captain R. S. Trevor, a victim of the plot organised by Mahomed Akbar Khan, following the outbreak of November 2nd, 1841, in Kabul, and the assassination of Sir Alexander Burnes, he was born at Jellalabad eight months before the murder of his father, and with his mother and brothers was among those in captivity after the massacre of the Jagdalak Pass. Educated at Oxford, he passed the Indian Civil Service Examination in 1860, and was posted to the Presidency of Bombay, where he had a long and distinguished career. While Commissioner of Customs he was chosen as British Delegate for the Portuguese Treaty. In November, 1890, he became Commissioner in Sind, and two years later the then Governor of Bombay, Lord Harris, called him to the Executive Council of the Western Presidency. Subsequently he was a member of the Governor-General's Council under Lord Elgin and Lord Curzon. Sir Arthur Trevor retired in 1901. He was elected a Life Member of the Society in 1891.

NOTES ON BOOKS.

English Public Finance from the Revolution of 1688. By Harvey E. Fisk. New York: Bankers' Trust Company.

This book has been prepared by the Bankers' Trust Company of New York, in order to give its American clients a better understanding of British finance and economics. The earlier chapters tell the story of the period August 4, 1914, to the budget speech of the Chancellor of the Exchequer on April 19, 1920. The later chapters discuss the national revenue, expenditure, and debt before 1914, and English methods of financing from the time of William the Conqueror.

The figures relating to the finances of the war are of very great interest, and no doubt their vastness will be as surprising to many in this country as to our friends in America. Thus Mr. Fisk points out that for the six fiscal years from March 31st, 1914, to March 31st, 1920, the expenditure of the Government actually exceeded the total expenditure for two and a quarter centuries preceding 1914. The exact figures are: for the 226 years £10,944,000,000; for the six years, £11,268,000,000.

The people of Great Britain paid into the coffers of the Government in taxes and other revenue collections over 36 per cent. of this vast sum of more than eleven thousand million sterling. The other 64 per cent. was borrowed. The war borrowings of Great Britain at their maximum, December 31st, 1919, amounted at par value of securities issued to £7,368,000,000, £6,011,000,000 furnished by her own people, £1,027,000,000 borrowed in and from the United States, and £330,000,000 borrowed from other foreign nations and from the Dominions. On the other hand, Great Britain had then loaned to the Dominions £186,000,000, and to her Allies £1,666,000,000, so that the amount loaned abroad exceeded by £495,000,000 the amount borrowed abroad.

Thus we find that the forty-six million people of the British Isles raised entirely from their own resources a net amount of £9,911,000,000, over £215 for each one of their number.

"What England requires to-day," writes Mr. Fisk, "to insure her material well-being is a heavy output of goods and services which the world will take in exchange for the food which she must buy in order to maintain her population and for the raw materials of manufacture, most of which she must seek without her own borders."

We are sincerely grateful to the Bankers' Trust Company of New York for having had this work prepared. It must assist in giving Americans a better idea of the enormous financial burden which has been thrust upon the shoulders of Great Britain by the war, and anything that will conduce to sympathetic mutual understanding between the two great English-speaking races on either side of the Atlantic deserves the warmest possible welcome.

The Centenary Volume of Charles Griffin & Co., Ltd. With a Foreword by Lord Moulton, P.C., G.B.E., K.C.B., F.R.S. London: Charles Griffin & Co., Ltd.

The firm of Messrs. Charles Griffin & Co. is to be congratulated on having completed a hundred years of useful service. Founded in Glasgow in 1820 the house soon decided to specialise in the production of technological works and scientific treatises mainly associated with industrial problems. It is difficult to exaggerate the importance of possessing a literature of this description. As Lord Moulton remarks in his foreword, "a rapid and sustained advance in our technology can alone save us from ultimate national disaster. With our huge populations, and their growing demands for food and increasing supplies of the necessary raw materials for our industries, there is no prospect of our being able to bear the burdens of the future, unless by advances in technology we are able to produce better and more cheaply than our competitors." In pouring out a constant stream of technological works of the highest order, then, Messrs. Charles Griffin & Co. may be said to have deserved well of their country.

The centenary volume opens with a short historical sketch of the firm, and this is followed by nine chapters written by well-known authorities describing the work carried out by Messrs. Charles Griffin & Co. in various branches of technology. Professor T. Hudson Beare deals with their record in connection with engineering. They published four works by Macquorn Rankine, then Professor of Engineering in the University of Glasgow, viz., "Applied Mechanics," 1858; "The Steam Engine,"

1859; "Civil Engineering," 1862; "Machinery and Millwork," 1869. These manuals are classics, and, to quote Professor Hudson Beare, "it is hardly an exaggeration to say that nearly all the engineering text-books which have appeared in the last half-century have to a great extent been modelled upon the lines laid down by Rankine, and are based upon principles which he first enunciated."

These works were followed by a long series of first-class productions, such as Professor A. Jamieson's "Steam and Steam Engines," "Applied Mechanics," "Strength of Materials," "Theory of Structures," "Hydraulics," and "Theory of Machines"; Farnsworth's "Constructional Steel"; A. E. Seaton's "Manual of Marine Engineering"; Bryan Donkin's "Gas, Oil, and Air Engines"; Professor Smith's "Suction Gas Plants"; and Professor Supino's "Land and Marine Diesel Engines." In short, the firm have provided engineers with text-books of the highest excellence in every branch of the profession. And what they have done for engineering they have also done for other callings: naval architecture, metallurgy, mining, chemical technology, medicine, the textile industries and science generally all owe a similar debt to Messrs. Griffin. Their record is a long and admirable one, and we wish them continued success under the guidance of their present chairman and managing director, Mr. Francis J. Blight.

GENERAL NOTES.

Société des Ingénieurs Civils de France (British Section).—The first meeting of this Section will be held at 8.30 p.m. on Tuesday, November 8th, at the Royal Society of Arts, when a paper on "The Destruction of the Mining District of Northern France, and the Work of Reconstruction" will be read by M. Edouard Gruner, President of the Société des Ingénieurs Civils de France. Fellows of the Society are cordially invited to attend.

A Cattle Food from Seaweed.—The exigencies of war have caused a number of attempts, more or less successful, to utilise Denmark's natural sources, and among the inventions reported is a process for producing a cattle food from seaweed. Several methods have already been proposed for producing such a food (more especially from sea wrack, *facus vericulosus*). This plant is abundant all over the world, but it has until now been impossible to transform it to a digestible state, and it also contains certain mineral substances which spoil the taste. The present process is described by the American Consul at Copenhagen as follows: The plant is thoroughly washed to get rid of the salt, then it is treated with steam, preferably under rather high pressure, which causes the cells to burst and allows the protoplasm to come out. This mass is placed under high pressure and formed into cakes, which are dried in a vacuum and ground into a coarse powder. The juice of the mass is boiled in a vacuum to a high grade of concentration which causes the salts to crystallize, and they are separated from the juice by means of a centrifugal separater. The juice is then mixed with the powder, and the mixture is pressed into pieces of suitable size. The analysis of the food is as follows: water, 5 per cent.; protein, 13·12 per cent.; fat, 1·07 per cent.; digestible carbonic hydrate, 66·76 per cent.; cellulose, 9 per cent.; mineral salts, 5·03 per cent. The analyses would seem to show this food to be nourishing, and the cattle are said to eat it willingly. It can be mixed with oil cakes.

Accidents in Mines.—According to the report of the Chief Inspector of Mines, the death-rate from accidents in and about mines under the Coal Mines Act for the year ending 31st December, 1919, was only 0·94 per thousand persons employed. This figure constitutes a record.

Sponge Industry in the Bahamas.—The gathering and the exporting of sponges are two separate branches of the sponge industry in the Bahamas, the gathering being still conducted in rather a primitive way. From a report of the United States Consul there, it appears that outfitters have a schooner or sloop locally built, at a cost of about £600 to £800, which is placed under the charge of a young captain, to whom a chance is offered for the buying of shares from his earnings in the vessel. One sponging boat is supplied by the owners with every schooner, while each member of the crew possesses his own boat also. The division of earnings at the end of a cruise of six weeks or two months is a complicated matter, the shares being allotted according to the man's position on board, private ownership of small boats, etc. All sponges obtained are sold on the Nassau Sponge Exchange by auction to buyers who ship the product to the United States and England. The total export of sponges in the year 1919 was 1,360,000 pounds, valued at 547,000 United States dollars, this amount including 337,000 pounds of sponge clippings valued at 4,000 dollars. Thus far scientific artificial propagation has not been pursued on any considerable scale.

Suggested Revival of Ancient Chinese Porcelain Industry.—An authority on Chinese porcelain is responsible for the statement, published by the United States Bureau of Foreign and Domestic Commerce, that it would be possible to produce such work to-day at the King Ta-chan potteries as in the days of Kang Hsi, although the cost would be practically prohibitive, and the colouring could not be duplicated, as the mineral colouring matter used is dug from mines in which the chemical components vary with the depth. It is said that the old moulds, patterns, and designs are still in existence, and that clay such as was used for the old ware is obtainable.

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FRIDAY, NOVEMBER 5, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

CASES FOR JOURNALS.

At the request of several Fellows of the Society, cases have been made for keeping the current numbers of the *Journal*. They are in red buckram, and will hold the issues for a complete year. They may be obtained, post free, for 7*s.* 6*d.* each, on application to the Secretary.

CANTOR LECTURES.

The Cantor Lectures on "Recent Research in Cellulose Industry," by CHARLES FREDERICK CROSS, B.Sc., F.R.S., have been reprinted from the *Journal*, and the pamphlet (price 1*s.* 6*d.*) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C. 2.

A full list of the lectures which have been published separately, and are still on sale, can also be obtained on application.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

ALUMINIUM AND ITS ALLOYS.

By W. ROSENHAIN, D.Sc., F.R.S.,

Lecture I.—Delivered April 12th, 1920.

PURE ALUMINIUM.

Particular interest has attached to aluminium ever since it was first produced on a commercial scale, mainly on account of its lightness. From the point of view of the present lectures also, we shall regard it mainly as a basis for the production of light alloys combining considerable strength with low specific gravity. From this point of view aluminium is practically the only metal available. At the present time the only practical alternative is the metal magnesium and its alloys, but these possess very considerable disadvantages, arising mainly from the fact that magnesium and its alloys are very easily corrodible. Another metal which may possibly come to be a serious rival to aluminium for the production of light materials of engineering is beryllium, otherwise known as glucinum. Of this, however, very little is yet known, and it is not yet available commercially.

Aluminium is of very widespread occurrence in nature. Many rocks and all ordinary clays contain a considerable proportion of aluminium. These materials, however, which are of the nature of impure silicate of aluminium, are not at the present time available for the production of the metal. The reason is that they do not readily lend themselves to economical treatment for the production of metal. The only sources of aluminium which are extensively used at the present time are the deposits of bauxite, which occur in various parts of the world. This mineral consists largely of oxide of aluminium (Al_2O_3), which is contaminated with varying proportions of iron and silica. One of the main difficulties in the metallurgy of aluminium, however, arises from the fact that the metal once produced cannot be readily refined. Consequently any impurities which are present in the ore in such a form that they become incorporated in the metal, cannot subsequently be removed economically. For the production of pure aluminium, therefore, it is necessary to utilise pure material, and this applies equally to the ore and to other materials which come into contact with the metal during manufacture.

The first step in the production of aluminium, therefore, consists in the purification of natural bauxite by chemical methods. This is an expensive and elaborate process. One method consists in the extraction of alumina from the bauxite by means of soda solution forming a solution of sodium aluminate. From this solution alumina (Al_2O_3) is deposited and soda is regenerated. More recently a process, for which

very great economy is claimed, has been put forward. In this a mixture of bauxite with carbon is heated in contact with an atmosphere of nitrogen to a temperature of from 1600° C. to 1800° C. As a result of this treatment, aluminium nitride is formed. Subsequent treatment of this nitride with soda yields ammonia and sodium aluminate. The ammonia thus produced is, of course, a valuable by-product, and it is said that alumina produced in this way costs little more than half that obtained by means of the older Bayer process.

Any steps which can be taken to secure a reduction in the price of aluminium are of vital importance to the industry of that metal and its alloys. The use of aluminium alloys as materials of engineering has become firmly established in certain directions during the war. If, however, it is hoped that their application may be extended to wider fields, it is essential that the cost of these materials should be very considerably reduced. Weight for weight, alloys are now obtainable which are far superior to steel, but on the other hand, steels—even the more expensive variety of alloy steels—are very much cheaper than aluminium or its alloys. Owing to the relative lightness of aluminium, however, this metal and its derivatives could successfully compete with steel even if the price of aluminium were still three times that of steel per ton. Even such a ratio, however, would require a diminution of the price to rather less than one-third of the lowest price level reached by aluminium before the war. It is obvious that such a development cannot be expected unless means are devised for utilising cheaper raw material and employing less expensive methods of treatment.

The final product of the purification of bauxite, which serves as the raw material for the production of aluminium metal, is pure, or nearly pure, alumina (Al_2O_3). The reduction of this oxide to the metallic state cannot be commercially carried out by the action of carbon alone. Electrolytic methods are therefore employed, and it is not possible to apply these to solution in water. The reason for both these difficulties lies in the very strong affinity which aluminium possesses for oxygen. Were it to be produced by electrolytic means in an aqueous solution, the metal would be instantly oxidised by action upon the water. The application of electrolytic processes has therefore to be carried out in fusion. Pure alumina, however, cannot be used for this purpose, because its melting point is far too high. The medium employed is therefore a solution of alumina in molten cryolite. Natural cryolite is a mineral found in Greenland, with a composition corresponding to the formula $Al_2F_6 . 6NaF$. A very satisfactory artificial product which serves as a substitute has, however, been produced, and this corresponds in composition to the formula $Al_2F_6 . 4NaF$. This material melts at a temperature near 1000° C., and is capable of holding a considerable amount of alumina in solution. The addition of 5 per cent. of alumina lowers the melting point to 915° C., and it is generally a fused mixture of this strength which is employed in the electrolytic reduction of aluminium.

The electrolytic reduction is carried out in a special and very simple form of electric furnace. In this appliance the current serves both to produce the electrolytic deposition of metallic aluminium, and to maintain the bath of molten cryolite at the proper temperature. The construction of the furnace is diagrammatically indicated in Fig. 1. A cavity for holding the molten bath is formed in a carbon block, A in

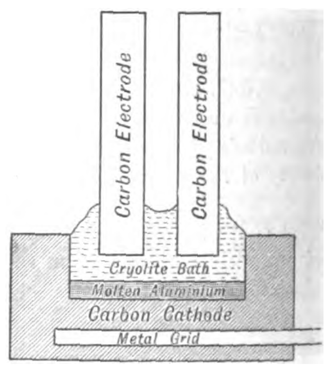

FIG. 1.

DIAGRAMMATIC VERTICAL SECTION THROUGH ELECTRIC REDUCTION FURNACE AS USED IN THE MANUFACTURE OF ALUMINIUM.

the Figure. In this carbon block is incorporated a metallic grid serving as electrode, to which one of the cables carrying the current is connected. The other pole is connected to the vertical carbon electrode, which hangs downwards into the molten bath. These furnaces work at a temperature of about 950° C., with a voltage between 6·5 and 7·5, a large number being connected together in series. The yield of aluminium is of the order of 1 kilogramme for 25 kilo-watt hours. The operation of these furnaces, however, involves certain special difficulties. In the first place, very great care must be taken in the manufacture of the

electrodes. Actually the amount of carbon consumed in the electrode is equal in weight, or nearly so, to the weight of aluminium produced. Any ash which is left after the consumption of the carbon of the electrodes necessarily enters the fused bath, and iron and silicon derived from the ash make their appearance as impurities in the metal. For the production of metal of a high degree of purity, therefore, it is very important that the carbon used for the electrodes should be very pure. Anthracite coal, which is usually regarded as a very pure variety of carbon, is not sufficiently good for this purpose, and it is necessary to employ coke obtained from the distillation of shale oils. For the production of very pure aluminium, it is further necessary for the workmen manipulating the furnace to exercise great care to avoid any risk of contaminating the metal by the use of iron tools, or by allowing any pieces of copper used in connecting up electrodes, etc., to fall into the bath. A further set of difficulties arises from the fact that there is only a very small difference of density between the molten aluminium, which is formed in the furnace and normally lies at the bottom of the bath, and the molten cryolite bath itself. Unless the working of the furnace is very carefully controlled, it may occur that through variations of temperature the density of the metal for a time becomes less than that of the bath. In that case the molten metal rises to the surface, and the output is spoilt.

When a sufficient quantity of molten aluminium has accumulated in the bottom of one of these furnaces, the bath is tapped and the molten metal is allowed to run out, first into ladles and is then poured into blocks. In this condition a certain amount of material derived from the molten bath itself is liable to be included mechanically in the aluminium. It is therefore necessary to subject the metal to a re-melting operation. After that process it is generally cast into the form of the well-known notched bars or ingots in which it comes upon the market.

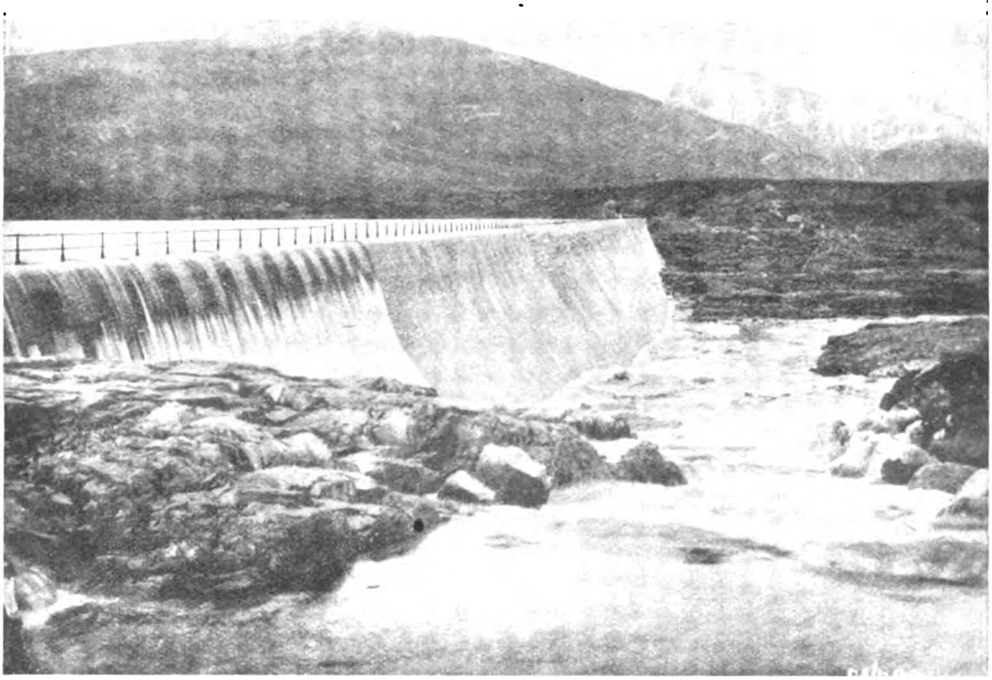

FIG. 2.

From the brief outline of the electrolytic manufacture of aluminium which has been given above, it will be seen that the economy of the whole process depends upon a cheap supply of electric power. It is therefore not surprising to find that aluminium manufacture has only proved practicable where cheap electric current could be obtained from water-power.

In Great Britain, aluminium manufacture is principally carried out in the works of the British Aluminium Co., at Kinloch Leven and at Foyers, both in Scotland, where water-power is available. By the kindness of the British Aluminium Co., photographs illustrating the works at Kinloch Leven are reproduced in Figs. 2, 3, 4 and 5. It has sometimes been suggested that the use of water-power for industrial purposes tends to spoil the natural beauty of mountain scenery. Indeed, a recent effort on the part of the British Aluminium Co. to extend their water-power considerably in the neighbourhood of Kinloch Leven was frustrated by the opposition of those who took the view indicated. Actually, however, it is found that the damming up of certain valleys, although it produces some changes in the scenery, does not by any means reduce its beauty; at any rate, it does so to a far smaller extent than would be the case by the erection of rows of smoking chimney stacks. Some of the photographs reproduced here may, perhaps, serve to show that the effect of the utilisation of water-power is not by any means so disastrous as is sometimes suggested.

FIG. 3.
WORKS OF THE BRITISH ALUMINIUM COMPANY AT KINLOCH LEVEN, SCOTLAND.

Having thus briefly outlined the manufacture of aluminium, we turn to consider its physical

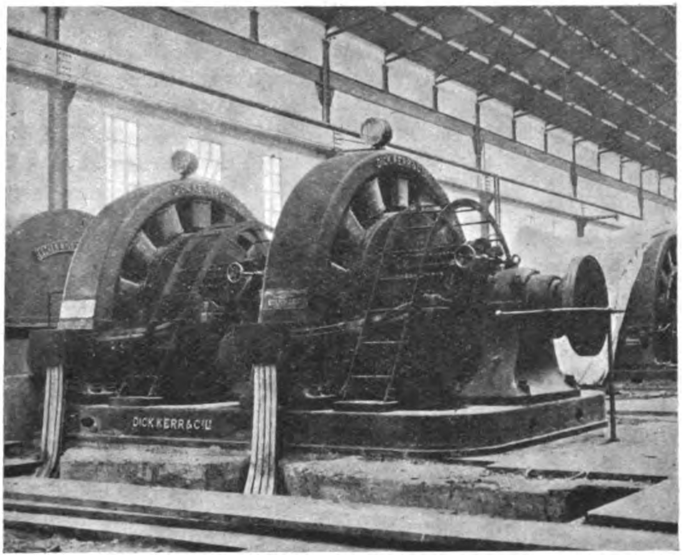

FIG. 4.

properties, which are remarkable and interesting. The first and most striking is the density, which is rather less than 2·6; this we may compare with the value for steel 7·8.

The thermal properties of aluminium are also remarkable and interesting. The thermal conductivity has a value of 0·51, as compared with 0·11 for iron. Combined with this high thermal conductivity, aluminium also possesses a very high specific heat (0·21), as well as a high electrical conductivity, which is about 60 per cent. of that of copper for equal volume, or 200 per cent. for equal weight.

The chemical properties of aluminium are also remarkable, and of very great importance. In the first place, it might almost be regarded as surprising that metallic aluminium can exist at all in an atmosphere containing oxygen and charged with moisture. We have already noted that the metal possesses a strong affinity for oxygen, and this property is utilised metallurgically. In the first place, there is the well-known thermite process in which iron and other oxides are reduced by the action of aluminium powder without the aid of external heat. Further, in the production of steel, and also in other metallurgical processes, aluminium is sometimes introduced as a cleansing and reducing agent at the end of the operation. Very large quantities of aluminium are used for this purpose in the steel industry.

In spite of this very strong affinity for oxygen, however, aluminium exists when exposed to ordinary air for a very long time without undergoing appreciable change. This apparent resistance to corrosion is due to the fact that the surface of the metal becomes coated with a transparent but protective film of oxide. The reality of the existence of this transparent surface film can be readily demonstrated, as has recently been done by Dr. Seligmann, by heating a sheet of thin aluminium foil. As a result of such heating the aluminium foil becomes largely oxidised. In spite of this

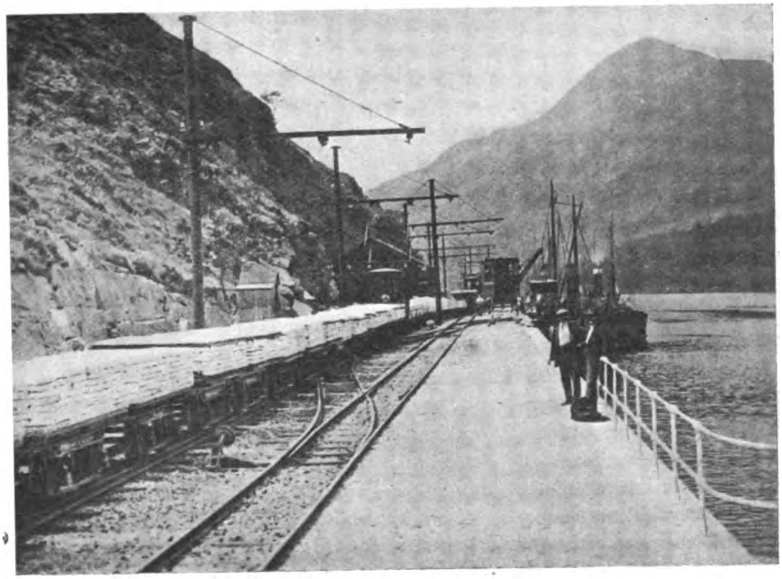

FIG. 5.

oxidation it retains its perfectly metallic appearance when viewed by reflected light. When, however, such a piece of oxidised foil is held up to the light, it is found to be very largely transparent. Similar evidence can be obtained from aluminium powder. Such powder can, by prolonged heating in a moist atmosphere, undergo very considerable oxidation, involving an increase of weight of more than 25 per cent. But the powder thus oxidised does not appreciably change in appearance.

The presence of a protective film on the surface of aluminium can also be demonstrated by the effects which arise when that film is removed. Where aluminium is exposed to the action of water, or even of a moist atmosphere, in such a way that the surface is constantly or frequently subjected to friction or abrasion, the frequent removal of the surface film leads to very rapid corrosion. The surface film can, however, be broken or removed in another way. If aluminium is exposed to the action of mercury under circumstances favourable to the combination of the mercury with the aluminium, that is, to the amalgamation of the aluminium surface, very striking results are produced. The presence of the mercury appears to destroy the protective action of the oxide film, and very rapid oxidation occurs. This can be shown very clearly by immersing a piece of aluminium sheet metal in a solution of mercuric-chloride for a very short time. After removing the metal from the solution and rinsing it with water and wiping it dry, a very rapid growth of alumina occurs on the surface of the metal. The alumina is formed in the shape of threads or fibres, which stand out from the surface of the metal like the fur of an animal. The process of oxidation is so rapid that the metal is perceptibly heated. (The lecturer demonstrated this phenomenon by painting the initials R.S.A. —Royal Society of Arts—on a piece of aluminium sheet with a brush charged with mercuric-chloride solution. The sheet was then rinsed and wiped, and in a few moments the initials began to appear in relief as the result of the rapid formation of oxide.)

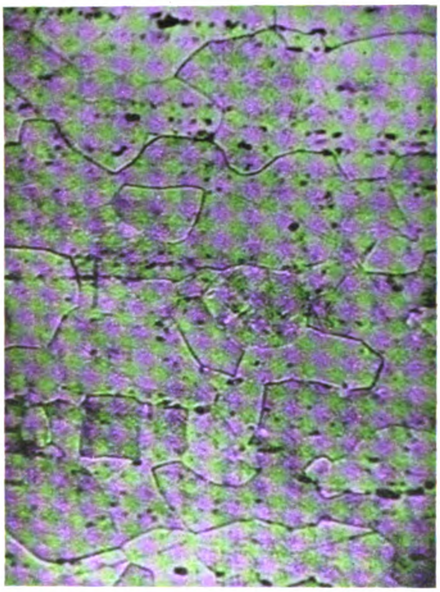

FIG. 6.

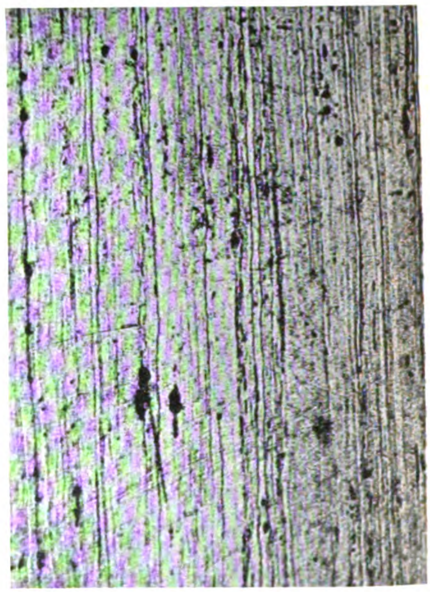

FIG. 7.

The protection of aluminium and its alloys from corrosion, is a matter of very great importance. In ordinary dry air, such as is met with in the interior of houses, railway carriages, etc., aluminium and many of its alloys preserve an untarnished surface for a very long time. No doubt it is this property which has given the metal the reputation which it appears to enjoy in some quarters of being particularly incorrodible. When, however, it is exposed to the action of water, and particularly of sea-water, very different results arise. Particularly if there is any friction, relatively rapid corrosion may set in, and this is liable to occur where the metal is exposed merely to spray and not actually immersed in the water. Protection can to a considerable extent be ensured by the use of protective organic coatings, such as varnish or bituminous paints.

Care must, however, be exercised in the choice of pigments employed for the coating of aluminium. It has been found that paints containing lead oxide are liable to be injurious, chemical action taking place between the aluminium and the oxide contained in the paint. Aluminium and its alloys can also be protected from corrosion to a considerable extent by electrolytic means. Aluminium placed in contact with steel, and exposed to water, is protected to a very large extent, but the corrosion of the steel is correspondingly accelerated. This is a result which is surprising at first sight, in view of the relative position of aluminium and iron in the electro-chemical scale. It is due, however, to the fact that the aluminium rapidly becomes coated with oxide, and thereby polarised electro-chemically.

The use of aluminium alloys of a particularly corrodible character as metallic protectors for aluminium, or its less corrodible alloys, has also been suggested recently.

Certain points of interest are presented by the micro-structure of aluminium. It should be mentioned in the first place, that the preparation of polished surfaces of pure aluminium is very difficult, owing to the great softness of the metal and the ease with which it is scratched, and with which it flows under the polishing operation. The structure of annealed aluminium is shown in Fig. 6 under a magnification of 150 diameters, while that of cold rolled material is shown in Fig. 7 under the same magnification. These photographs show the ordinary structure met with in approximately pure metal in the annealed and cold rolled condition respectively. Since, however, so-called pure aluminium is never entirely free from either iron or silicon, traces of these impurities are always to be found in the micro-structure. This is true even of the very purest varieties of aluminium ever produced, which probably attained a purity of 99.7 per cent. During the war, and at the present time, the standard of purity has been very much reduced, and so-called pure aluminium may not contain more than 98 per cent., and at best rarely contains more than 99 per cent. of aluminium. The appearance of iron and silicon in aluminium is illustrated in Fig. 8, under a magnification of 1,000 diameters. Silicon, when visible under the microscope, exists in the form of crystals of free silicon; iron, on the other hand, exists in the form of the compound $Fe\ Al_3$. These two bodies crystalise together in a peculiar manner, as indicated in the photograph, and a considerable amount of investigation has been necessary in order to make it possible to identify them definitely. With regard to silicon, it is interesting to notice that the whole of the silicon contained in the metal does not appear in the form of a separate micro-constituent. A certain amount may occur in the form of solid solution, and the amount found in this form will depend upon the thermal and mechanical treatment which the metal has undergone. When a chemical analysis is made of a sample of aluminium, it is found that the silicon appears in two forms; one part of the silicon becomes oxidised during the operations of dissolving the metal and appears as silica in the analysis. On the other hand, that portion which is present in the aluminium in the form of crystals of free silicon, remains

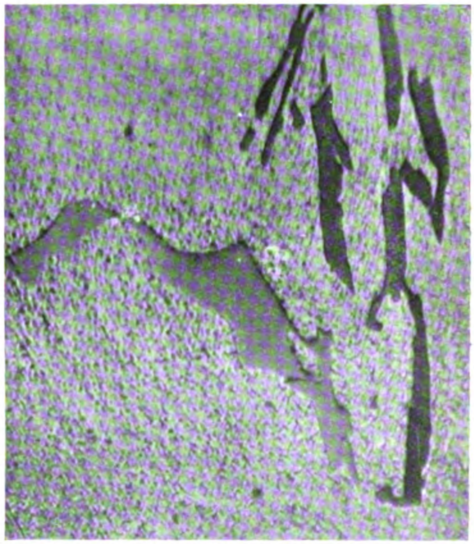

FIG. 8.

unaffected by the re-agents used, and appears as undissolved silicon in the residue. Microscopic evidence, however, completely explains this peculiar behaviour.

We turn now to consider the mechanical properties of pure aluminium, and it will be seen at once that from this point of view the metal is very disappointing. The tensile strength of commercially pure aluminium in the cast, rolled, annealed, and cold rolled states, is shown in Table I., p. 798, together with corresponding data for steel and brass.

It will be seen that the figures for aluminium are comparatively very low, and as a result the uses of aluminium for engineering purposes where strength is required are very limited indeed. It is actually valued mainly for its lightness, its very great ductility, and its colour,

TABLE I.—PURE ALUMINIUM.

Condition.	Yield Stress. Tons to sq. in.	Ultimate Stress. Tons to sq. in.	Extension. per cent. on 2 in.
Cast. 1 in. diameter.	2·3	5·22	37
Chill shaped sand.	2·5	4·90	24
Rolled. Rod 13-16 in. diameter	6·5	7·20	30·5
Sheet. (Hard)	9-10	10-11	5-6
14 gauge (soft).	1·2-2	6-7	19-25
Drawn. Rod 13-16 in. diameter	8·5	8·7	19·5
Rolled *Mild Steel*	16·4	30·0	41
Rolled *Brass*	21·5	25·0	35

and power of resisting atmospheric corrosion. It is accordingly used wherever lightness is essential without great strength. It is used in the form of castings, rods, wires, and sheets, including among other uses, a considerable application as a conductor of electricity. It is also employed for panelling, and in the form of powder for paints, explosives, etc. One use with which many people are familiar is for cooking utensils. For more serious purposes of engineering, however, it is necessary to use alloys of aluminium which possess very much greater strength and hardness. It is, therefore, not surprising to find that the development of the engineering uses of aluminium has depended entirely upon the discovery of alloys capable of combining, as far as possible, the light weight and other advantageous properties of the metal itself, with a greater degree of strength and hardness.

BRITISH EMPIRE EXHIBITION, 1923.

As stated in the *Journal* of August 13th, it is proposed to hold in London in 1923 an exhibition representative of the industries and resources of the Empire. The objects, according to a White Paper, are "to foster Inter-Imperial interests from both a commercial and a political standpoint, and to demonstrate the natural resources of the territories of the Empire, and the inventive and manufacturing energy of its peoples. The exhibition will be privately organised, but is receiving official recognition and support. His Majesty the King has given it his patronage, and H.R.H. the Prince of Wales has consented to act as President of the General Committee."

In the House of Commons on Monday Mr. Kellaway (Secretary, Department of Overseas Trade) moved the second reading of a Bill authorising a Government guarantee up to £100,000 subject to private guarantees. Another stipulation is that the Board of Trade shall approve the manager of the exhibition, the executive committee, and the general conditions under which the exhibition is carried on. In the course of his speech Mr. Kellaway said:—

"The idea of the exhibition originated, I think, with Lord Strathcona. The idea was also supported by the Dominions Royal Commission appointed in 1912, and that Commission stated in its report that they found a general feeling not only in the United Kingdom, but also in the Dominions, that Inter-Imperial Exhibitions were likely to have an increasing tendency to promote Imperial trade, and that such exhibitions should afford a valuable opportunity to British manufacturers for developing their trade in the growing markets of the Dominions. The advent of the great war prevented that great idea from being carried through, and for five years it was in abeyance.

"At a Conference, held in 1919, at which were present representatives of this country and of all our great Dominions, it was decided that it was desirable that the proposal should be pushed ahead, not only with the objects which were originally behind the idea, but in order to provide a memorial of the great part played by the Empire during the war. The Empire in the war proved both its unity and its resources, and it is desirable, now that we are faced with the almost equally difficult and complex problems of peace, that the Empire should once more demonstrate its unity and its resources in dealing with these problems. Looking at it more particularly from the point of the interest of the United Kingdom, it has to be remembered—I think it is too often forgotten—that the United Kingdom itself is not a self-supporting unit; that it can only live by a great overseas trade."

The exhibition, he continued, was a form of Imperial Preference which raised no controversy. The possibilities for British trade within the Empire had not yet been sufficiently realised. It was regrettable that before the war the percentage of trade done with our oversea Empire showed a diminution, but there had been an improvement since the Armistice. In 1913 our exports to the Empire oversea amounted to £208,900,000, or 32·9 per cent. of the total bulk of our exports. In 1919 the figures were £215,300,000—and there was no comparison possible between the figures of 1913 because of the fall in the value of money—or 22·4 per cent. The figures for the first six months of this year were much more satisfactory, £236,700,000, or 30·6 per cent. That was a gratifying improvement, but we were dealing with an Empire population of, roughly, 450,000,000, and the possibilities of Empire trade were enormous. The exhibition would enable much more to be done in increasing that trade. The Committee of Management was very representative and strong, and the Guarantee Committee, which was going to secure the guarantee of £500,000 from private sources, contained some of the best-known men in the City.

Sir Frederick Banbury opposed the Bill on the ground that the time is not opportune for spending £100,000 on any project, however good. On the other hand, Mr. Clynes said that the proposal offered Parliament an opportunity to do a great amount of good to internal Empire trade. It was a step which would result in diminishing unemployment, and ought to have the support of every Labour member of the House.

After further discussion the second reading was agreed to by 205 against 30.

AIRSHIPS AND SEAL-FISHING.

In connection with the article on the Seal Oil Industry, which appeared in the last issue of the *Journal*, it is interesting to hear of a new development, particulars of which are contributed to the *Times* by a special aeronautical correspondent. The S.S. "Alconda" sailed from the Thames last week for Newfoundland, carrying four non-rigid airships, which are to be used early next spring in an attempt, by means of aerial observation and wireless telegraphy, to direct the course of the steamers setting out from St. John's in search of the seal herds which come drifting down on the ice from the far North.

The expedition, which has been organised and is being taken out by Mr. Frank J. Tippen, consulting airship engineer and constructor to the Newfoundland Government, and a well-known expert in this country on the design of large commercial airships, is a very complete one. Three of the four airships are of the "S.S." or sea-scouting type which, known familiarly as "Blimps," and driven by a single "Hawk" Rolls-Royce motor, did such valuable reconnaissance work in the war over the North and Irish Seas. The fourth is a larger ship of the same type, driven by a couple of Rolls-Royce motors. These four ships, with all necessary equipment and ample spares, have been presented to the Newfoundland Government by our Air Ministry as the nucleus of a regular Government air patrol service in Newfoundland, and after the experiment in seal-hunting they will be used as a matter of routine in survey work and forest patrol. The experience thus gained by the Newfoundland authorities will be of the utmost value and will, it is hoped, lead to the institution of other airship patrol services in different parts of the world.

Probably two of the airships will be employed in the first seal locating test, which will be made early next year. They will fly out over the North Atlantic, and keep in touch during their observations by means of the wireless apparatus they will carry with the fleet of sealing steamers, which puts out to sea each season from its base at St. John's with the intention of intercepting the vast herds of young seals congregated on the moving ice.

It is the young seals, with their oil-bearing fat and skins, which are so valuable. But the locating of the herds is always more or less a race against time. Immediately after the breeding season the seals come drifting down on the ice in their thousands, and their position must be located accurately and the catch made all within the period of a week or two.

Hitherto, in laying out a course likely to bring the steamers to the correct spot at the right time, the sealing fleet has relied mainly on the special knowledge and skill of certain skippers who study charts and drifts, and make the most of such information as comes to hand. But there is no certainty in such a method, and calculations go wrong sometimes, and the fleet to a large extent draws blank. Next spring, however, it is believed that the airship patrol, preceding the fleet and scouting over an immense area of water, should convert what has hitherto been a "gamble" into a practical certainty.

PETROLEUM IN MEXICO.*

A comparison of the figures of the production of oil in Mexico, in the United States, and in the world since 1912, shows that the Mexican production has multiplied more than three times in the last seven years. While in 1913 Mexico supplied only one-fifteenth of the world's production of oil, in 1918 it furnished more than one-eighth.

The statistics show that the world's actual production of oil in 1918 was about 515,000,000 barrels. The potential production of Mexico during 1919 was 547,000,000 barrels. By the term "potential production" is meant the amount of oil that would be produced if each well were permitted to flow without any restraint being placed on it. In 1919 Mexico was potentially able to produce 32,000,000 barrels more oil than was actually produced in all other countries in 1918, and 170,000,000 barrels more than the United States production of 377,000,000 barrels in 1919. The potential production of the wells already drilled and producing in Mexico is estimated at from 1,500,000 to 1,900,000 barrels daily. But only about 12 per cent. of the potential capacity of the wells in Mexico is being actually produced. The full development of the potential possibilities of the industry in Mexico has been hindered by the lack of transportation both for oil and materials, by the lack of sufficient storage facilities, and by the disorganised political conditions of the country. The application of new legislation to the industry, the effect of which it has not been possible fully to ascertain at this time, has tended to check development operations. Yet the exports of oil from Mexico in the first half of 1920 show a notable increase over the shipments in previous years, amounting to nearly 60,000,000 barrels, and representing an increase of 72 per cent. over the exports in 1919. If this rate of increase is maintained throughout the year, the total exports for 1920

* Extracted from Report on the Petroleum Industry of Mexico issued by the Bureau of Foreign and Domestic Commerce, Washington ("Commerce Reports," 13th September, 1920).

will reach 135,000,000 barrels in comparison with 78,000,000 barrels in 1919. The rising rate of exports is shown in the following table of the monthly shipments of Mexican oil in the first half of each of the last two years :—

Months.	1919. Barrels.	1920. Barrels.
January . . .	5,294,786	8,160,841
February . . .	4,911,984	7,687,943
March	5,179,076	10,560,535
April	6,132,903	10,155,279
May	6,329,722	12,052,568
June	6,917,641	11,220,720
Total, 6 months	34,766,112	59,837,886

The enormous output of the wells in Mexico can best be illustrated by a comparison with the wells in the United States. The oldest wells in America are in the Appalachian region, and number about 100,000, with an average daily yield of less than two-thirds barrel per well; the newest region is the Rocky Mountain with 400 wells and an average per well of 40 barrels daily; the mid-Continent field of America with nearly 50,000 wells averages 9 barrels daily; the California field with an annual production of about 100,000,000 barrels, yields an average of 30 barrels daily per well. If all the producing wells of Mexico are taken into consideration, we find that during 1919 the average actual production per well was approximately 1,000 barrels daily. There are twenty-five wells in Mexico, which, if permitted to flow without restraint, would yield 600,000 barrels daily, or an average of 24,000 barrels per well per day. During the first six months of 1919, eight producing wells were drilled in the Tampico region with a possible daily flow of 584,798 barrels.

Increasing attention is now being given to the exploration of various parts of the Republic for the discovery of oil. Geological conditions indicate that petroleum fields of greater importance than those now known will yet be discovered in Mexico. A late report places the zone of possible production in the Gulf Coast States at over 80,000,000 acres, on the Pacific at about 50,000,000 acres, and in Lower California at about 18,000,000 acres, a total of 148,000,000 acres, or 230,000 square miles. Of this immense area only about 6,500,000 acres have been investigated, which illustrates the scope offered for wildcat operations in Mexico. The combined area of the fields now being exploited in Mexico does not exceed 800 square miles. The discovery of what is believed to be extensive petroleum deposits on some islands in the Gulf of California has been officially announced by the Mexican Government. These islands are close to the shore of Sinaloa, due west of Hermosilla, and the deposit is said to extend to the mainland on the peninsula of Lower California. The southern district of this peninsula has given indications of an extensive petroleum zone, and it is being thoroughly explored.

Explorations are also being carried on in different parts of Mexico. Reports from geologists indicate that any discoveries made as a result of these explorations will probably be of a petroleum with a paraffin base, or with a smaller amount of asphalt than that now being produced.

The potential production of oil has been very seriously diminished by the invasion of salt water in several of the most important fields, including the Tepetate, Huasteca, and Casiano. The Potrero del Llano well, the property of the Mexican Eagle Company, after flowing for eight years and having produced more than 100,000,000 barrels of oil, began to yield salt water, and since December, 1918, it has been considered a loss. In November, 1919, the Casiano No. 7, actually producing 25,000 barrels daily, and owned by the Huasteca Petroleum Company, turned to salt water. The loss of this well caused this company to drop from first to second place in the production of Mexico in 1919. The wells of the Cortez Oil Corporation in Tepetate have been reported as having become a total loss through salt water. Seven of the principal wells of the Chinampa field have either ceased to flow or are yielding only water. From the Mexican Government's figures of a potential production of 1,592,740 barrels daily in March, 1919, and of 1,995,223 barrels daily in November, 1919, it would appear that the menace from salt water had not reached any great proportions, but it must be noted that during this time of apparent increasing potential production, the various companies had developed and brought in several new wells which more than offset the losses from salt water. The appearance of salt water in several of the oldest and largest producing fields will probably stimulate the exploration and development of other fields, particularly the known fields farther south.

Of the total investments in the oil industry of Mexico, 97 per cent. is held by foreigners. In the petroleum industry of the United States but 4 per cent. of the total amount invested is held by foreign capital. In 1918 there were twenty-seven companies in Mexico which produced oil in commercial quantities, seventeen of these being owned by Americans, five by Spanish-Mexican capital, three by Dutch, and two by British interests. Of the total of 63,828,326 barrels produced in Mexico in 1918, the American interests produced 73 per cent., British 21 per cent., Holland 4 per cent., and Spanish-Mexican 2 per cent. In 1919, however, the British interests materially increased their production. Only American and British interests shipped oil from Mexico during 1918, the oil exports having been 79 per cent. American and 21 per cent. British.

Production of oil in Mexico depends primarily, at this time, on transportation facilities. Mexico can ship oil only up to the maximum amount of ship tonnage available, and it is equally true that it is impossible to utilise this tonnage to the utmost if there are no pipe lines to move the oil to the ports. Certain conditions, both economic and political have brought about in some Mexican fields a surplus of pipe-line facilities, while in others, particularly the newer fields, production is delayed while lines are being constructed. It

has been estimated that the monthly shipments of 6,000,000 barrels of petroleum could be increased to nearly 17,000,000 barrels if adequate transportation were available. New pipe lines now under actual construction will increase the carrying capacity by about 200,000 barrels per day, and lines have been projected with a carrying capacity of 100,000 barrels daily. Not all the pipe lines are provided with pumping stations, these being unnecessary in many cases, owing to conduction by gravity. A great amount of the oil obtained in the Elbano, Panuco, and Topila fields is of such a low gravity and high viscosity that it cannot be economically pumped through pipe lines. The transportation of the Elbano oil is accomplished after removing the asphalt and heavy constituents and shipping the fuel oil in tank cars. A considerable amount of the oil from this district is used for fuel by the Mexican railroads. The Panuco product is exported from Mexico and has to be barged down the Panuco River to Tampico, where it is either loaded directly on the ships or stored. The oil from this district has such a high viscosity that it must be heated before delivering to barges or before loading on tank ships from storage.

Of the total exports in June, 1920, the shipments from the Tampico district amounted to 10,566,181 barrels. From Puerto Lobos the shipments were 3,384,513 barrels, and from Tuxpam 1,472,553 barrels. The United States took 71 per cent. of the total, South America 8 per cent., Great Britain 4 per cent., Cuba 3 per cent., and Mexico itself 4 per cent., the small remainder going to various countries of North America and Europe. In accordance with its usual record the Huasteca Petroleum Company was the largest shipper, its exports for the month of June totalling 2,189,750 barrels. Production was somewhat curtailed in June by floods in the lower country, which damaged the oilfields.

It is of interest to compare the above figures of Mexico's exports with the United States statistics of imports of Mexican oil. The total imports of oil from Mexico into the United States in the fiscal year ended 30th June, 1920, reached the record figure of 2,821,693,174 gallons, or 67,183,170 barrels (at 42 gallons to the barrel). This shows a gain of 991,598,069 gallons, or 23,609,478 barrels, over the imports of the 1919 fiscal year, which amounted to 1,930,095,105 gallons, or 45,954,645 barrels. The gain was 100 per cent. over the imports of 1918, when the imports were somewhat more than 1,000,000,000 gallons. The June, 1920, imports of Mexican oil were 340,197,600 gallons, or slightly more than 8,000,000 barrels.

The Carranza Government of Mexico was overthrown in May, 1920, by what amounted practically to a peaceful revolution. Adolfo de la Huerta, former governor of Sonora, has been chosen President *ad interim* by Congress pending the holding of a congressional and presidential election in the autumn of 1920. The public utterances of the principal persons in the new Government, as reported in the press, indicate a desire on their part to deal fairly with the foreign corporations engaged in the exploitation of Mexico's resources.

On July 2nd, 1920, the *Universal* of Mexico published the statement, which was claimed to be official, that the petroleum industry in Mexico was worth 600,000,000 pesos (300,000,000 dollars). This statement has been verified by a well-known engineering and geological expert. In detail the investments in the petroleum industry follow:—

	Dollars.
1,000 (approximately) wells perforated and producing	100,000,000
Value of the land upon which the wells are located	50,000,000
Pipe lines, railroads, and rolling stock	50,000,000
Refineries machinery, and buildings	50,000,000
Miscellaneous producing properties, of which the greater part belongs to Great Britain	50,000,000
	300,000,000

To the above might be added approximately 50,000,000 dols. as being invested in ships for the transportation of oil. American capital represents about 70 per cent. of the total investments in the petroleum industry in Mexico, and British and Dutch capital about 27 per cent., the remaining 3 per cent. being Mexican and other interests.

JAPAN'S FOREIGN TRADE.

The foreign trade of Japan for the first half of this year totalled 2,756,134,000 yen, comprising exports to the value of 1,138,838,000 yen, and imports to the value of 1,617,296,000 yen. There was thus, as the Commercial Secretary of the British Embassy in Tokio points out, an unfavourable balance of 478,458,000 yen, or more than double the adverse balance for the similar period of last year. Compared with the first half of 1919, exports show an increase in value of about 35 per cent., and imports an increase in value of about 55 per cent.

The exports which showed increases in value were raw silk, silk textiles, cotton textiles, refined sugar, waste silk, cotton yarn, braids for making hats, pottery, coal, timber, toys, tea, buttons, hats, and cement. Generally, however, there was hardly any increase in the quantities shipped; but braids for making hats, and matches, were noteworthy exceptions.

The exports which exhibited decreases were copper (ingots and slabs), iron (bars, rods, and plates), zinc (ingots and slabs), beans and peas, starch, woollen textiles, leather goods, and beer. The most notable decrease was in the case of copper. Japan is generally a copper-exporting country, but owing to the increased cost of output the local product has ruled considerably higher than the imported metal. There was naturally no outlet for Japanese copper, and the large merchants were obliged to import heavily in order to fulfil their commitments.

The imports showing increases included raw cotton, wool, oil cake, hides, pulp, woollen textiles,

flax and hemp, cotton textiles, caustic soda, soda ash, leather, toys, rubber, petroleum, nitre, sugar, beans and peas, machinery, rails, coal, lead (ingots and slabs), iron (bars, rods, plates, ingots, slabs, pipes and tubes, nails). The most noteworthy increase was that of raw cotton. This was in response to the expansion in the local textile industry, but owing to the slump a large proportion of it has been regarded as surplus stock, and holders were subsequently reported to be trying to re-export.

The imports which decreased were rice, copra, paper, and ores.

The continued excess of imports is, to a considerable extent, the result of the steady import of raw cotton from America during the first part of this year, which had been held up owing to various causes, such as strikes of stevedores and shortage of space. The sudden change in all economic conditions which occurred during the period under review, brought about a general suspension or curtailment of textile manufacture to begin with, and also of the production of silk, cotton yarn, hosiery, etc., and the difficulty in securing accommodation from the banks, combined with the unusual fluctuation of prices in the local markets, acted as a strong deterrent on export trade.

The Commercial Secretary adds that a great number of orders have been cancelled, and there will be strong retrenchment in such commodities as raw cotton and other raw materials, fertilisers, and, probably, machinery. It is also expected that there will be a decrease in the export of most of the articles which showed a heavy increase during the first half of the year, such as silk textiles, cotton textiles, waste silk, and sugar. However unsatisfactory the sale of raw silk may be, it is hoped that the figures for the latter half of the year will show an increase as compared with the first half-year. This hope may be justified so far as quantity is concerned, and the same may be stated about cotton textiles, silk textiles, and cotton yarn; but prices have gone down enormously. For instance, raw silk, which rose to 4,300 yen per bale during the latter part of last year, and to over 3,000 yen during the earlier part of this year, ruled at the close of the half-year at 1,400 yen to 1,500 yen per bale.

TOBACCO TRADE AND INDUSTRY OF HONG KONG.

The full scope and volume of the tobacco industry and trade of Hong Kong is not generally understood; in fact, it has not been fully appreciated in Hong Kong itself until recently. The publication of the trade statistics of the colony for the first six months of 1919 gives definite figures of the value of the trade for the first time, and is illuminating. The statistics point to a total value of the exports of prepared and other tobacco from the colony for 1919 of well over £2,000,000 sterling. The imports will probably reach a value of over £900,000, exclusive of those from South China, which amount to about £500,000 more; and the difference between imports and exports in a general way measures the value of the tobacco-working industry of Hong Kong.

The statistics of imports and exports for the first six months of 1919 are, in pounds sterling, as follows:—

	First six months of 1919.	
	Imports.*	Exports.
	£	£
Cigars	28,620	79,780
Cigarettes	136,440	598,432
Snuff	20	233
Tobacco:—		
Prepared, foreign	4,559	3,770
Prepared, native	4,094	309,267
Raw	222,895	211,543
Stalk	—	2,065
Total	396,628	1,205,090

* Exclusive of imports from South China.

According to a report by the United States Consul-General at Hong Kong, there are three lines of tobacco manufacture in the colony. One is a large cigarette factory, started several years ago by Chinese capitalists from Canton, and is known as the Canton Nanyang Brothers Tobacco Co. (Ltd.). The second factor is a large cigar factory which was started several years before the war as a branch of a Manila factory, and is known as the Oriente Cigar Factory. Like the Manila concern, it was owned more or less completely by German interests; with the inception of the war it was taken over by the Hong Kong Government for liquidation. It has been operated as a going concern by the liquidators ever since, and is responsible for most of the difference between the imports and exports of cigars noted above. Very little of the product of this factory is used locally. The third principal factor is the industry of the native tobacco dealers, in which the raw leaf is imported and manufactured mostly into fine-cut tobacco for use in native Chinese pipes, especially the small nickel and brass water-pipes.

Of the imports of cigars, the Philippine Islands furnish all but a small fraction; and of the imports of cigarettes about 20 per cent. came from Great Britain, about 7 per cent. from the Philippine Islands, and nearly the whole of the balance from North China, where the chief competitor of the local factory has its factories. Approximately 60 per cent. of the raw tobacco indicated in the official returns comes from the United States, the rest coming mostly from North China. But by far the larger part of the raw tobacco actually imported comes from South China. The value of the imports from South China (not included in above table) is about £600,000 per annum. The returns of the Chinese Maritime Customs give the

exports of tobacco leaf and stock to Hong Kong in 1918 as the equivalent of £182,000, and of prepared tobacco as the equivalent of £418,000. Most of this tobacco is of a cheap grade.

About two thirds of the cigars manufacted in Hong Kong, and of the cigars manufactured elsewhere and re-exported from Hong Kong, go to Central and North China, Siam and the Straits Settlements also being fair customers. About 40 per cent. of the exports of cigarettes go to China, 35 per cent. to the Straits Settlements, and most of the rest to the Dutch East Indies and other places where Chinese emigrants are numerous. Two-thirds of the prepared native leaf tobacco goes to the Straits Settlements, and most of the balance to Indo-China. Of the exports of native raw tobacco, the United States and Great Britain take about 20 per cent. each, Egypt about 25 per cent., and China most of the balance. During the war the export of this native leaf to Europe, and especially to the United States, became very large, for use in the manufacture of "Turkish" cigarettes.

It is of interest to note in this connection that experiments have been carried on for some time by the Botanical and Forestry Department of the Colonial Government in Hong Kong, with a view to producing in the colony itself tobacco leaf suitable for the manufacture of cigars. A considerable degree of success is to be noted, and experimental lots of cigars have been made. There is a considerable amount of terrain in the mainland portion of the colony considered suitable for the production of a high-grade leaf, and it is thought that under proper superintendence and instruction a large production of such tobacco can be developed.

CAMPHOR INDUSTRY IN FUKIEN.

A "boom" in the camphor-producing industry in the Foochow district commenced in 1904 and lasted about six years. In 1906, 1,516,600 lb., valued at about £193,000, were exported from Foochow; in 1917 the exports amounted to only 49,533 lb., valued at about £5,700.

At first a Japanese concern was granted a monopoly of the business; but this was cancelled on account of the protests of other foreign firms. An attempt of the Provincial Government to make a monopoly of the trade had injurious results. Trees were ruthlessly cut down and none planted to replace them, so that the reckless exploitation and lack of reafforestation soon killed the trade. The Government issued a regulation providing that five young trees should be planted for every one cut down, but nothing was done. Fukien camphor could not withstand the competition of Formosa camphor, which was produced by more up-to-date methods.

In 1918 there was a slight improvement due to the high prices offered, which made it profitable for certain dealers to expand their businesses. In that year exports from Foochow amounted to 56,533 lb., valued at about £11,000.

According to a report by the United States Consul at Foochow, camphor is now produced in the interior of that district to a limited degree by crude native ways of distillation. The product is brought by porters to the Min River or its branches and carried to Foochow by native boats.

The Government is anxious to revive the trade, and might be willing to bear at least a part of the expense of reafforestation. It is estimated that a capital of about £30,000 would be necessary to undertake the work on an adequate scale, but perhaps with modern distillation the trade could be made profitable, at least for a time. A foreign firm, unless backed by the Provincial Government, would meet endless difficulties in finding and recompensing the real owners of camphor trees. The trees do not grow in forests, but are scattered. When a tree is found near a grave it is necessary to purchase it from the owner of the grave as well as from the owner of the tree itself. There are no railways or good roads in North Fukien, and transportation is imperfect and expensive. Labour, however, is cheap.

CORRESPONDENCE.

CATTLE FOOD FROM SEAWEED.

In connection with the paragraph on the above subject in the *Journal* of October 29th, it is interesting to note that in Iceland, where there is very little pasturage, particularly in winter, the sheep near the coast go down to the beach and climb amongst the rocks to obtain seaweed, which they use as a food. It must be admitted that seaweed gives rather a peculiar taste to the flesh of the animals, and I am wondering whether it will be the same with the prepared cattle food which is now being made in Denmark.

When I was in Iceland in 1913 one farmer lost ten sheep by the rapid rising of the tide, and I understand that sheep are often lost in this way.

F. MOLLWO PERKIN.

OBITUARY.

LORD BELHAVEN AND STENTON.—Alexander Charles Hamilton, 10th Baron Belhaven and Stenton, died at his Scottish seat, Wishaw, on October 31st. A son of William John Hamilton, M.P., F.R.S., who was twice President of the Geological Society, and a grandson of William Richard Hamilton, antiquarian and diplomatist, who had so much to do with the collection of the famous Elgin Marbles, and recovered them after the vessel, in which they were being transported, was wrecked near one of the Ionian Islands, he was born in 1840, and entered the Royal Engineers in 1857. He saw active service in the Zulu War of 1879, and retired from the Army in 1888 with the rank of Colonel.

A few years later, on the death of his kinsman, James, he established his claim to the barony, which was created in 1647. He sat in the House of Lords as a Scottish Representative Peer since 1900, and having lost his only son, the Master of Belhaven, in the war, is succeeded by his nephew, Lieutenant-Colonel Robert Edward Archibald Hamilton, C.I.E., Financial Member of the State Council at Jodhpur.

In 1878 Lord Belhaven, then Major Hamilton, joined the Society, and in 1885 he was elected to the Council, a position he continued to fill, with one interval, until 1901. He also served for many years on the Colonial Section Committee. He frequently presided at meetings of the Society, and on numerous other occasions took part in discussions. In view of the present position of motoring, it may be interesting to recall some comments he made when presiding, about twenty years ago, at the reading of a paper on "Cycling: Historical and Practical." He rather complained of the author of the paper for not carrying on his history to the "very last development in which the rider had little or nothing to do except to supply himself with an auxiliary steam engine, on which he sat, and which did his work for him." They did not know, he added, how far such things might be developed; cycles which would run for many hundreds of miles without much assistance from the driver might become very practical things.

An enthusiastic and persistent advocate of the metric system, he once introduced a Bill into the House of Lords providing for the compulsory adoption of that method of measurement after the lapse of four years.

NOTES ON BOOKS.

Examples of Modern Bookbinding. Designed and executed by Robt. Rivière & Son. London: Bernard Quaritch, Ltd.

Examples of Bookbinding Exhibited at the Leipzig Exhibition in 1914. London: Robt. Rivière & Son.

The bindings of the books referred to in the second of these volumes were designed and executed with the special object of being shown at the Leipzig Exhibition in 1914. Unfortunately, after they had been on view for a few weeks the Great War broke out and the exhibition was closed. The exhibitors were naturally extremely anxious as to the fate of their works on which the utmost care had been expended, and it is satisfactory to learn that the books have at last been returned to them none the worse for their experiences.

The illustrations in the first volume are in colour, those in the second are in black and white. Most of them are exceedingly beautiful, and they deserve very careful attention on the part of all interested in a fascinating art. It seems out of place to select particular specimens and attempt to describe them; failing the opportunity of seeing the bindings themselves, the only way to obtain a fair idea of their excellence is to study these illustrations, which are admirably produced. One result of such study is to confirm the writer in his opinion that in work of this description the strictly conventional is the only wear: in his opinion the least successful examples are those in which appear more or less realistic representations of the human body.

GENERAL NOTES.

Leather from Germany.—The Parliamentary Secretary to the Board of Trade, replying to a question in the House of Commons on October 25th, stated that during the first nine months of this year the registered imports of dressed leather consigned from Germany amounted to 4,571 cwts., and of undressed leather to 126 cwts. No leather had been imported by way of reparation or indemnity.

Oil Resources of the United Kingdom.—In the House of Commons on October 27th the Government were asked what steps, if any, are now being taken to discover new sources of oil fuel and oil shales in this country; and whether a definite policy with regard to any oil fuels that may be discovered in the kingdom has yet been arrived at. Mr. Kellaway replied as *follows:* In addition to eleven Government borings in Derbyshire, Staffordshire, and Scotland, three licences have been granted to companies or persons wishing to bore for petroleum. A company is now engaged in developing the oil shale deposits of Norfolk. With regard to the second part of the question, the matter is still under consideration.

International Advertising Exhibition.—This exhibition will be held at the White City from November 29th–December 4th, 1920. The Reception Committee are reserving a number of free invitation tickets for Fellows of the Royal Society of Arts, and those desirous of visiting the Exhibition should apply to the International Advertising Exhibition, Reception Committee, 167, Strand, W.C. 2.

Canada and Emigration.—Some interesting articles contributed to *Canada* by Mr. J. Obed Smith, Superintendent of Emigration for Canada in Europe, have been reprinted in pamphlet form with the title "The Value of an Emigrant." The author mentions *inter alia* that 65 per cent. of the Canadian population were born in the Dominion; that the immigrants during the last twenty years numbered nearly 3,500,000, and that of those who arrived during the year before the war 108,000 were English, 30,700 Scottish, 9,700 Irish, and 2,000 Welsh. In a chapter headed "It will Pay Canada," he points out that the cost of transport is in existing circumstances largely prohibitive for the domestic and other classes chiefly needed by the Dominion, and that the Imperial Government's "war gift" of free transportation ceases at the end of the present year.

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FRIDAY, NOVEMBER 12, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

OPENING OF THE 167th SESSION.

The 167th Session of the Society will be opened on Wednesday, November 17th, at 8 p.m., when an experimental address on "Wireless Telegraphy and Telephony" will be delivered by MR. ALAN A. CAMPBELL SWINTON, F.R.S., Chairman of the Council. It is hoped to show, amongst other things, the automatic printing in ordinary Roman type of wireless messages received in the lecture hall from a distance. This will be the first time that this fresh departure in wireless telegraphy has been exhibited.

ARRANGEMENTS FOR THE SESSION 1920-21.

Particulars of the arrangements for the forthcoming session, so far as they are at present completed, have been posted to all Fellows of the Society. Any Fellows who have not yet received them are requested to communicate with the Secretary.

CANTOR LECTURES.

The Cantor Lectures on "The Decoration and Architecture of Robert Adam and Sir John Soane," by ARTHUR THOMAS BOLTON, F.R.I.B.A., F.S.A., Curator, Soane Museum, have been reprinted from the *Journal*, and the pamphlet (price 2*s*. 6*d*.) can be obtained on application to the Secretary, Royal Society of Arts, John Street, Adelphi, W.C. 2.

A full list of the lectures which have been published separately, and are still on sale, can also be obtained on application.

CASES FOR JOURNALS.

At the request of several Fellows of the Society, cases have been made for keeping the current numbers of the *Journal*. They are in red buckram, and will hold the issues for a complete year. They may be obtained, post free, for 7*s*. 6*d*. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

ALUMINIUM AND ITS ALLOYS.

By W. ROSENHAIN, D.Sc., F.R.S.

Lecture II.—Delivered April 19th, 1920.

The brief account of the properties of pure aluminium, given in the previous lecture, suffices to show that for many engineering purposes this metal in its pure state is entirely unsuited. Not only in the cast condition, but also when rolled, and even when hardened by cold rolling it is still too soft and weak for uses where heavy stresses have to be borne. It has accordingly long been the aim of metallurgists interested in aluminium to discover alloys which shall provide the desired strength, toughness, and stiffness. It must be remembered, however, that the feature which primarily makes aluminium attractive from the engineering point of view is its lightness, and it is therefore necessary that any satisfactory alloy shall combine, as far as possible, the desired degree of strength and ductility with a retention of the low specific gravity of the pure metal. With the exception of some special alloys produced by the addition of magnesium to aluminium, all the well-known alloys of aluminium are heavier than the pure metal. The superiority of any alloy over pure aluminium, therefore, depends upon the ratio which the improvement, brought about in the mechanical properties by the addition of other metals, bears to the increase of density which accompanies them. This ratio really determines the value of any alloy from the point of view of combined strength and lightness. The great difficulty in arriving at a numerical value, however, which shall furnish a just basis for comparison and classification of different materials, lies in deciding what typical property or combination of properties is to be regarded as indicative of "strength." In many respects one is accustomed to regard "strength" as merely

equivalent to "tensile strength," and although tensile strength does give a valuable indication of the general typical character of a metal, it must be borne in mind that there are many other forms of stress to which materials are exposed, and that the resistance of a metal to pure tension does not necessarily measure resistance to shear, compression, or alternating stresses. If, however, we accept tests of tensile strength as our guide for the moment, it is possible to express the value of an alloy, from the point of view here under consideration, by a fraction in which the tensile strength per unit area is divided by the weight per unit volume. This ratio, to which I have given the name "Specific Tenacity," may be more precisely defined in the ordinary British units as being equal to the tensile strength in tons per square inch, divided by the weight of one cubic inch of the material in pounds.

Long ago, Galileo hit upon another method of expressing this same ratio. If a rod, bar, or even wire, of a metal is suspended vertically, the upper portion of the piece is exposed to a tensile stress equal to the weight of that part of the metal hanging below it. It follows, therefore, that for every material there is a maximum length whose weight it can just support. This maximum length of its own material, which the metal is able to support, is a measure of the specific tenacity, and the value of an alloy may therefore be expressed in terms of such a length. In actual cases these lengths run into miles, ranging from three to fifteen.

Accepting the fact that it is necessary to improve the mechanical properties of pure aluminium before the metal can be used for many engineering purposes, we may next inquire how that improvement is to be brought about by the addition of other elements. It is readily understood if we glance at the microstructure of pure aluminium, which in many respects is very similar to the microstructure of other pure metals. This has already been illustrated in Fig. 6 of the first lecture. That figure represents the typical structure of a pure metal, which is known to consist of an aggregate of a large number of minute crystals. When a material having such a structure is exposed to severe stress, the crystals themselves undergo deformation by a process of slip which occurs within each of the crystals. If now we wish to strengthen the material, in order to give it increased resistance to stress, there are two methods which are open to us. In the first place, it is possible to stiffen up the crystals themselves by adding to the metal another element, generally also a metal, which remains in the solid material uniformly disseminated throughout the crystals, and exercises its strengthening and stiffening effects within those crystals themselves.

The second method which is open to us is to introduce into the microstructure a second new constituent. Certain elements when added to the pure metal do not remain uniformly disseminated throughout the crystals of that metal, but make their presence felt by the appearance of a second constituent in the interstices and boundaries of the original crystals. The second constituents produced in this way are always harder and stronger, but at the same time more brittle than the crystals of the original metal. When, therefore, the second constituent is present in small amounts, it serves merely as a strengthening and stiffening framework, which locks the crystals together and assists them to resist deformation by stresses applied from outside. This strengthening effect is, however, accompanied by a reduction in ductility, and when the amount of the second constituent becomes large this reduction in ductility becomes serious, and ultimately the alloy becomes brittle. The two types of alloys resulting from additions of metals, producing the two kinds of effects just described, are known as "solid solution" alloys and "duplex" alloys respectively. For the majority of purposes the solid solution alloy in which no second constituent is present has many advantages, particularly because it is possible to add much larger quantities of the alloying element if it remains in the form of a second solution, than if it becomes separated in the form of a second constituent. It is, however, possible to combine the advantages of both, either by using two or more alloying elements, or by using an alloying element which, while present in small amounts, remains in solid solution, yet appears as a second constituent when added in larger quantities.

In the case of aluminium we meet with this difficulty, that there are comparatively few elements which form long series of solid solutions with our metal. A long range of solid solution alloys can be formed with hardly any other metal than zinc; considerably shorter ranges of solid solubility are met with in the case of magnesium, copper, and nickel. On the other hand, in the case of such metals as iron, molybdenum, tungsten, vanadium, and others, the range of solid solubility is practically zero, and a second hard and brittle constituent makes its

appearance almost as soon as one of these metals is added to aluminium.

What has just been said is enough to indicate that in the search for valuable alloys of aluminium, the best guidance is to be derived from a knowledge of the constitution and structure of the various alloy systems in question. This kind of knowledge is now available, to a very large extent, in the form of a series of diagrams known as constitutional diagrams or equilibrium diagrams, which represent in full detail the results of metallographic study. This metallographic knowledge, which is partly derived from a study of heating and cooling curves and partly from a careful and systematic examination of the microstructure of the alloys under various conditions of treatment, was not, however, available to anything like a sufficient extent a few years ago.

When, therefore, the increasing uses of aluminium for war purposes rendered it necessary to extend our investigations, a very large amount of work had to be undertaken in exploring and studying the constitution and structure of alloy systems in which aluminium played a principal part. This had to be extended not only to the comparatively simple systems, consisting of two metals—that is to say, of aluminium and one added metal, but also to the much more complicated and difficult cases of alloys containing three metals—that is to say, aluminium and two added metals, such as zinc and copper, silicon and magnesium, and others. We cannot here go into the method by which the exploration has been carried out, nor yet into a detailed account of the results which have been arrived at. Some of these require for their representation models constructed in three dimensions, because it is not possible to represent the constitution of ternary alloys in a simple plane diagram. All we can do here is to glance briefly at the constitutional diagrams and microstructures of a few typical alloy systems, which are of importance in connection with light alloys, and to see in what manner the mechanical properties of these alloys are correlated with their constitution and structure.

The first example we shall consider is that of the alloys of aluminium with copper alone. These have received attention from investigators a good many years ago, one of the most important papers dealing with the matter having been published by my predecessor at the National Physical Laboratory, now Professor H. C. H. Carpenter, F.R.S., and Professor C. A. Edwards, in the Eighth Report to the Alloys Research Committee. From the present point of view, however, the most important detail of the equilibrium diagram is that representing the range of solid solubility of copper in aluminium. This it has been necessary to redetermine carefully by modern methods, for the purpose of arriving at more exact data than were formerly available or required. This portion of the equilibrium diagram is reproduced in Fig. 9. It will be seen that at a relatively high temperature (536° C.), where solidification is just complete, a solid solution of copper in aluminium can exist which contains when in equilibrium as much as 5 per cent. of copper. This is represented by the point *P* in the diagram. The downward curved line *PQ* in the diagram, however, indicates that the solubility of copper

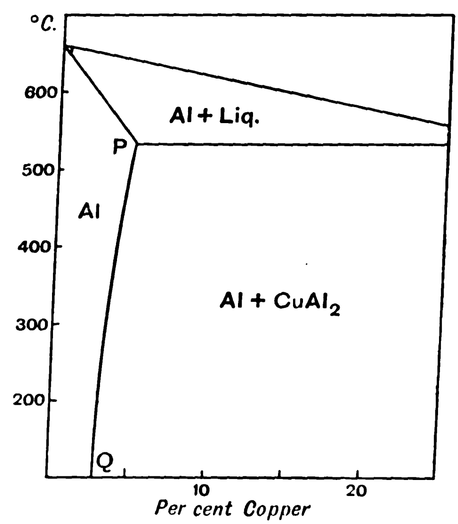

Fig. 9.

in aluminium diminishes with falling temperature, until at the ordinary temperature not much more than 3 per cent. of copper can remain in solid solution. It must be borne in mind, however, that the solid constituent, which separates from these alloys when the range of solid solubility is passed, is not copper, but an aluminium-copper compound $CuAl_2$, a hard but brittle body possessing the characteristic properties of the second constituent referred to above.

The diagram shown in Fig. 9 represents the condition assumed by the alloys when complete equilibrium has been attained. The attainment of complete equilibrium, however, is a matter of considerable time, either during very slow cooling or during prolonged heating at suitable temperatures. As ordinarily cast, the alloys do

not assume even approximately the equilibrium condition, and the result is that the full degree of solid solubility is never attained in alloys prepared under ordinary conditions. As a result, when 2 per cent. of copper is present the cast alloys already show the presence of the second constituent. This is evident in the photomicrographs of these alloys which are shown in Figs. 10 and 11. Fig. 10 represents the structure

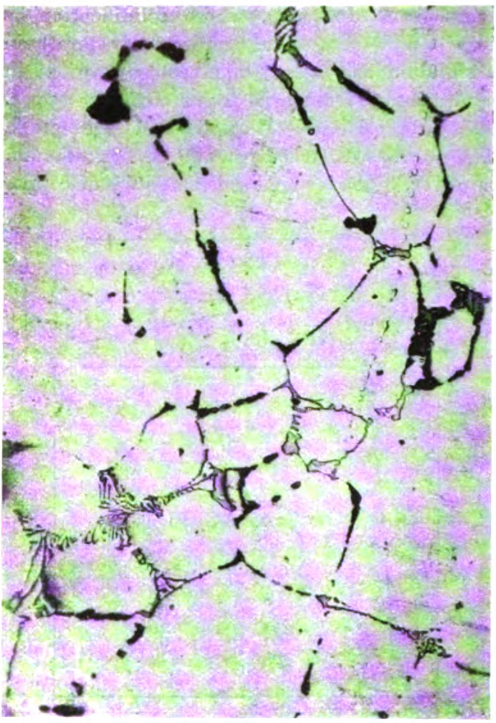

FIG. 10.
ALLOY OF ALUMINIUM CONTAINING 2 PER CENT. COPPER.
Magnification by 150.

of an alloy of aluminium containing 2 per cent. of copper cast in a sand mould, under a magnification of 150 diameters. Fig. 11 shows an alloy containing 3 per cent. of copper when in the form of rolled bars. In both cases, the presence of the second constituent makes itself evident in the dark-etching patches which are visible in the photographs. When larger amounts of copper are added to the alloys, the proportion of this dark-etching, hard, and brittle constituent present in the alloys is very considerably increased. This is clearly indicated in the micrograph, Fig. 12, which represents a section from a chill casting of an alloy containing 12 per cent. of copper, under a magnification of 150 diameters. Here the amount of the dark etching body $CuAl_2$ is very considerable. This particular alloy has been used a great deal, but its value for engineering purposes has probably been very considerably overrated. The mechanical properties corresponding to the alloys, whose constitution and structure we have just discussed, is shown in Table II., which refers to the alloy of aluminium containing 4 per cent. of copper.

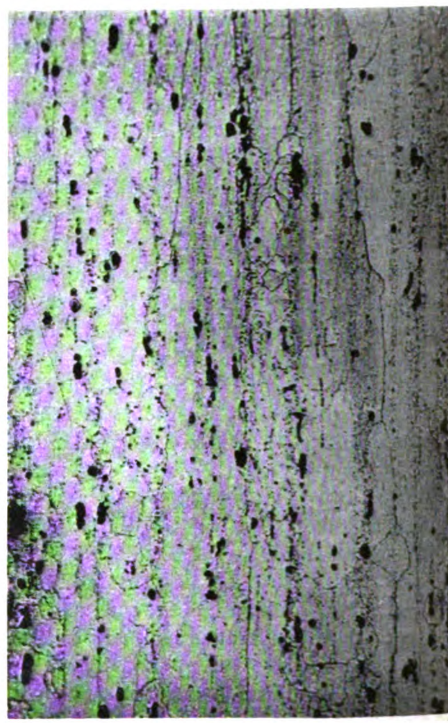

FIG. 11.
ALLOY OF ALUMINIUM CONTAINING 3 PER CENT. COPPER IN THE HOT-ROLLED CONDITION.
Magnification by 150.

TABLE II.—COPPER 4%. ALUMINIUM 96%.

Condition.	Yield stress, tons per square inch.	Maximum stress, tons per square inch.	Extension per cent. on 2 inch.
Sand Cast Rod, 1 inch diameter .	4·9	7·5	5
Chill Cast Rod, 1 inch diameter .	5·4	9·6	10·5
Rolled Rod, ⅞ inch diameter .	11·6	17·0	21
Drawn Rod, ⅞ inch diameter .	18·5	20·0	7·5
Sheet, 18 gauge as rolled	15·9	18·6	4
Sheet, 18 gauge annealed 500° C. .	4·9	11·7	25

It will be seen that in the chill cast condition this alloy attains a maximum stress of 9·6 tons per square inch, coupled with an elongation of 10 per cent. on 2 in. In the rolled condition it reaches a tensile strength of 17 tons per square inch with an elongation of 21 per cent., and by cold drawing the tensile strength can be raised to 20 tons per square inch, but the elongation suffers a corresponding fall. This alloy, it will be seen, represents a very considerable advance on the strength of pure aluminium, but it has been materially improved upon by other materials.

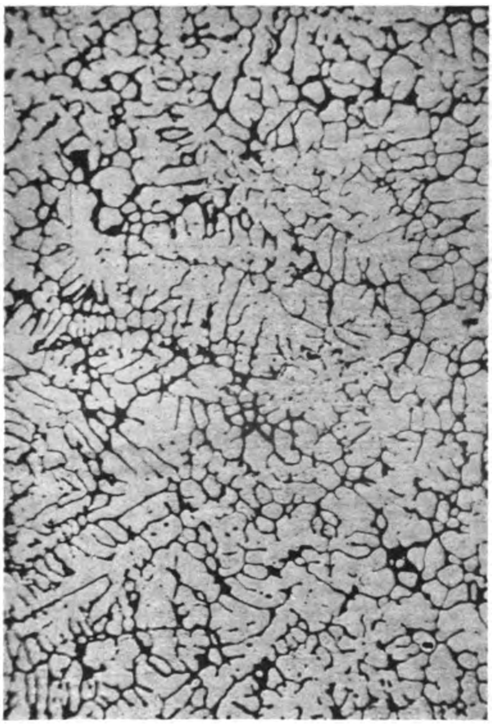

FIG. 12.
ALLOY OF ALUMINIUM WITH 12 PER CENT. COPPER. CHILL CASTING.
Magnification by 150.

The mechanical properties of the alloy containing 12 per cent. of copper, the remainder being aluminium, are shown in Table III.

TABLE III.—COPPER 12% (CAST ALLOY).

	Chill (1 in. diam.)	Sand (1 in. diam.)
Yield stress, tons per sq. in. .	6·4	5·0
Maximum stress, tons per sq. in.	9·7	7·9
Extension, per cent. on 2 in. .	1·5	1

This alloy, of course, cannot be rolled or drawn, so that no comparison is possible with the higher figures of Table II. In the chill cast condition, however, this alloy with a tensile strength of 9·7 tons per square inch shows no advantage whatever over that containing 4 per cent. of copper, while it is appreciably heavier. Further, where the 4 per cent. alloy shows an extension of 10 per cent. on 2 in., coupled with the same tensile strength, the extension in the case of the 12 per cent. copper alloy is down to 1·5 per cent. This agrees well with the much larger amount of the brittle copper compound which is seen in the photo-micrograph.

The alloys of aluminium with copper alone can be slightly improved upon by the addition of a small amount of manganese. If it is not desired further to harden the alloy, the manganese should be used in place of part of the copper. Thus in the 4 per cent. copper alloy, 1 per cent. of copper may be replaced by 1 per cent. of manganese giving an alloy containing, copper 3 per cent., manganese 1 per cent., the remainder being aluminium. The mechanical properties of this alloy are shown in Table IV.

TABLE IV.
COPPER 3%. MANGANESE 1%. ALUMINIUM 96%.

Condition.	Yield stress, tons per square inch.	Maximum stress, tons per square inch.	Extension per cent. on 2 inch.
Sand Cast Rod . .	6·0	7·5	5
Chill Cast Rod . .	7·3	12·1	13
Rolled Rod, ⅞ inch diameter .	12·8	16·5	15

Here the chill casting attains a tensile strength of 12 tons per square inch, coupled with an extension of 13 per cent. on 2 in. This is a very appreciable advance on the figures obtained with 4 per cent. of copper alone. There is also some evidence to show that the alloy containing a small amount of manganese has certain other advantages, particularly in regard to its power of resisting corrosion.

The next group of alloys to be considered are those consisting of aluminium and zinc. Their constitution and properties have been very fully described in the Tenth Report to the Alloys Research Committee of the Institution of Mechanical Engineers by the present lecturer, and Mr. S. L. Archbutt, in 1912. Considering first the constitution of these alloys, the equilibrium diagram is shown in Fig. 13. This diagram is admittedly incomplete in regard to

one or two special points; it shows, however, that a series of solid solutions are formed, containing zinc up to 40 per cent. The alloys which are of any practical importance, so far as light materials are concerned, are those containing less than 30 per cent. of zinc, and in regard to the constitution of these, at all events, there is no room for doubt. When brought into a condition of complete equilibrium, all these alloys show the typical structure of a solid solution closely resembling that of a pure metal. This is shown in the micrograph, Fig. 14, under a magnification of 100 diameters, which represents an alloy containing 15 per cent. of zinc after it has been rolled and annealed. When these which refer respectively to the properties of sand castings, chill castings, and rolled bars ½ in. in diameter, produced by hot rolling.

As regards Fig. 16, referring to sand castings, it will be seen that the ultimate strength increases up to, and slightly beyond, a zinc content of 40 per cent. In the case of chill castings, a first maximum is reached at 30 per cent., and a second higher maximum at 50 per cent. of zinc. In the case of the hot rolled bars ½ in. in diameter, the tensile strength rises up to a zinc content of 26 per cent., this being the limit of the alloys which can be satisfactorily rolled into bars and sheets.

In comparing the tensile strength of different

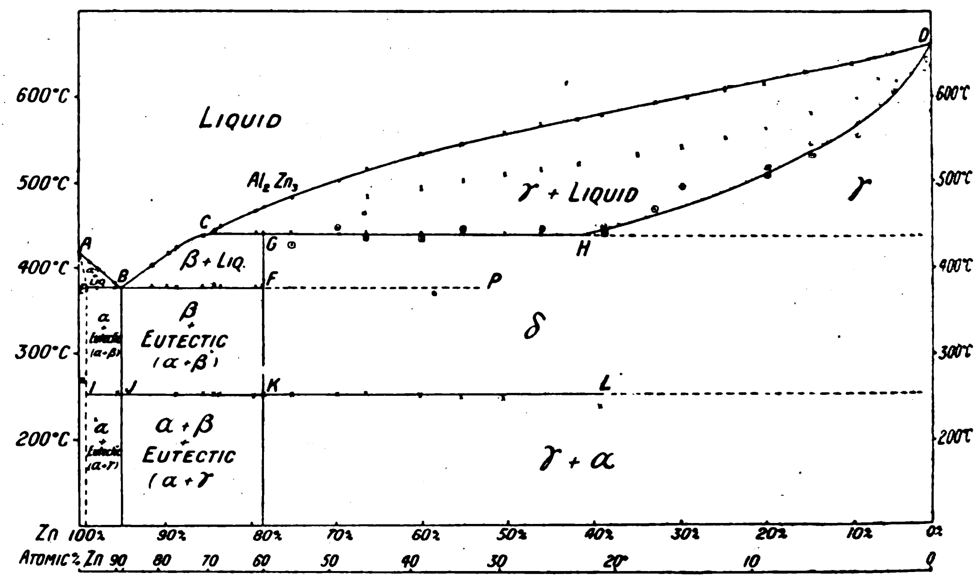

FIG. 13.

alloys are cast, however, they exhibit a markedly different micro-structure, arising from the fact that solid solutions during crystallisation deposit successive layers having different compositions, and these differences of composition are only removed by the process of diffusion which occurs when the alloys are subjected to prolonged heating, and particularly when heating is accompanied by mechanical work. The typical appearance of these alloys in the cast condition, showing the structure known as "cores," is shown in Fig. 15, under a magnification of 100 diameters, which represents an alloy containing 20 per cent. of zinc in the chill cast condition.

The mechanical properties of the alloys of aluminium and zinc, so far as tensile strength is concerned, are shown in Figs. 16, 17, and 18, members of this interesting series of alloys, however, it is important to remember that an increase of zinc content brings with it also a corresponding increase of density. Relative merits of the various alloys, therefore, are to be gauged in terms of their specific tenacity, a term which we have already defined as being measured by the ratio of tensile strength to weight per unit volume. This ratio and its variation with zinc content, in both sand and chill castings, is shown in the graph of Fig. 19. It will be seen that the maximum specific tenacity is reached in the neighbourhood of 25 per cent. of zinc for both sand and chill castings.

The comparison of specific tenacity is, further, of considerable interest, not only as between different members of the same group of alloys.

but also as between the alloys of aluminium with zinc and those of aluminium with copper. This comparison is shown in the diagram, Fig. 20, which relates to rolled bars 1½ in. in diameter. Here it will be seen that the alloy containing 17 per cent. of zinc has a higher specific tenacity than any of the rolled alloys of aluminium with copper alone. With higher zinc content, the specific tenacity of the zinc alloys attain still higher values.

While the mechanical properties of the aluminium-zinc alloys are themselves remarkably promising, further improvement can be obtained by adding to them small percentages of copper, thus obtaining ternary alloys of aluminium with zinc and copper. The complete exploration of a ternary system is a matter of very great difficulty, owing to the enormous number of alloys which it is necessary to examine in order to obtain satisfactory exploration of the whole field of possibilities which such a system presents. In the case of the aluminium-zinc-copper system this exploration has been carried out to a very large extent, but it would occupy too much time and space to reproduce the results in any detail in this lecture. We must, therefore, confine ourselves to one particular example, and this has been shown because of the particular practical interest which attaches to it.

In selecting an alloy out of a series, such as the aluminium-zinc series, in which specific tenacity increases with increasing zinc content, it does not follow that for any and every purpose it is desirable to use the alloy having the highest specific tenacity. It may be found, for instance, that unduly increasing the zinc content brings with it incidental disadvantages, such as difficulties in the foundry and others. Actually, the alloys very rich in zinc have the serious disadvantage that they are very soft and fragile when hot, so that they are very liable to be slightly cracked as the result of shrinkage or insufficiently careful handling. This consideration alone makes it desirable to keep the zinc content of an alloy, intended for extensive practical use, as low as possible. Further, castings particularly cannot be made of less than a

Fig. 14.
Alloy of Aluminium with 15 per cent. Zinc.
Rolled and Annealed.
Magnification by 100.

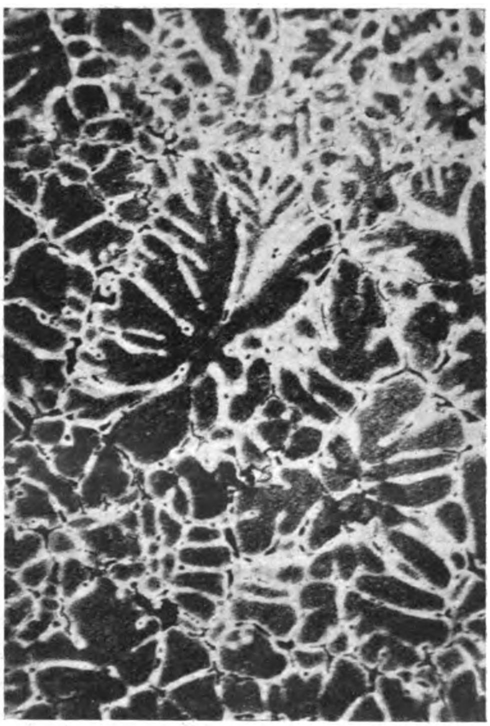

Fig. 15.
Alloy of Aluminium with 20 per cent. Zinc.
Chill Casting.
Magnification by 100.

certain thickness which is necessary to ensure the flow of metal into the various parts of the mould, and also to give the resulting piece sufficient robustness for handling in the workshop and in practical use. The very high specific tenacity of an alloy, however, can only be fully

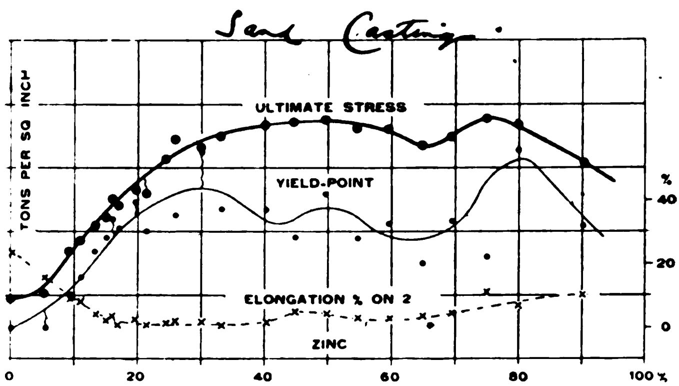

FIG. 16.

utilised if weight can be reduced by reducing thickness. Where the limiting thickness is reached before the specific tenacity is fully utilised, it is preferable to use an alloy of actually lower density, in spite of the fact that its ratio of strength to density may be smaller than that of heavier alloys.

It became necessary during the war to make a selection of this kind in arriving at an alloy to be used generally for castings, which were not intended to be exposed to high temperatures. Examples of such castings are, of course, crank

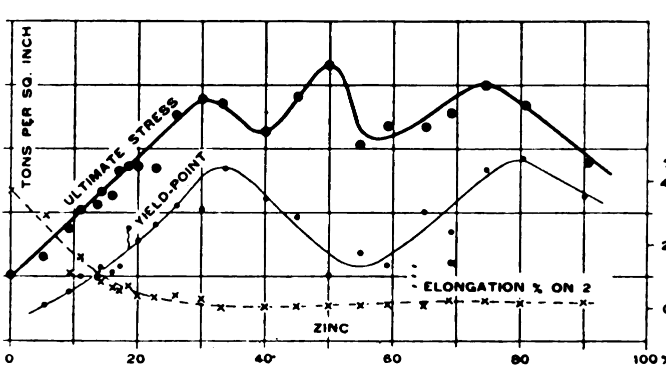

FIG. 17.

cases, and many other parts of internal combustion engines, excluding, however, such objects as pistons or cylinder castings.

The selection arrived at, on the basis of a balance of the best physical properties on the one hand, as compared with the various other considerations indicated above, led to the choice of an alloy containing somewhat less than 15 per cent. of zinc. Advantage, however, was taken of the benefits to be derived from the presence of copper in such an alloy.

The effect of the presence of 3 per cent. of copper in an alloy of this type is indicated in Table V., which shows the yield stress, maximum stress, and extension per cent. on two inches of sand cast and chill cast test pieces from two alloys, one containing 15 per cent. of zinc without any copper, and the other containing 3 per cent. of copper as well as 15 per cent. of zinc. It seems that the presence of the copper brings with it an increase in tensile strength of from two to three tons per square inch.

TABLE V.

	Sand cast.		Chill cast.	
	0 to 15	3 to 15	0 to 15	3 to 15
Yield stress, tons per square inch	9·6	9·8	5·8	7·0
Maximum stress, tons per square inch	11·1	14·4	11·7	13·9
Extension, per cent. on 2 inch	2	3	8·5	6·5

If the addition of zinc is carried somewhat further, a very interesting type of alloy is reached with a zinc content of 20 per cent. and a copper content of 3 per cent. The properties of this alloy in the cast condition, both as cast in sand and in chill, are shown in Table VI., p. 813. Here it will be seen that a tensile strength as high as 17¼ tons per square inch has been obtained. Where light alloy castings are desired, having the highest available tensile strength, there can be no doubt that this alloy offers advantages over the one previously described. It is, however, appreciably heavier and, unless the casting can be made proportionately thinner, advantage cannot be taken of the higher specific tenacity of this material.

The micro-structure of the alloys containing copper as well as zinc, such as the two whose properties have been described above, is interesting because it shows that the addition of copper to these zinc alloys brings about a combination of both the methods of stiffening and hardening a pure metal, which were discussed at the beginning of this lecture. The aluminium-zinc alloys alone are of the nature of simple solid solution—that is, the alloys have been strengthened by a stiffening of the crystals themselves, owing to the presence in them of zinc. The copper, on the other hand, makes its presence felt by the formation of a second constituent, consisting of the aluminium-copper compound Cu Al_2, which appears dark in the photo-micrograph. In the cast alloys, however, the coring of the aluminium-zinc solid solution crystals is very marked, and a complex structure appears under the microscope. This is illustrated in Fig. 21 under a magnification of 150 diameters. After prolonged annealing, particularly if coupled with mechanical work, much of this complexity disappears, and we have either a simple solid solution containing both zinc and copper in the original crystals, or a certain amount of the aluminium-copper compound remains present in the form of dark etching patches scattered among the aluminium-zinc crystals.

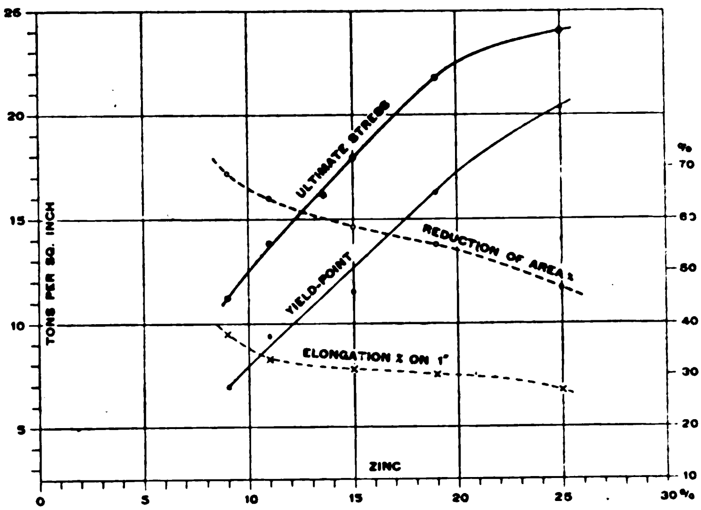

FIG. 18.

TABLE VI.—3 TO 20 ALLOY.

	Sand cast, 1 in. diameter.	Chill cast, 1 in. diameter.
Yield stress, tons per square inch	5·5	6·0
Maximum stress, tons per square inch	16·0	17·5
Extension, per cent. on 2 inch .	3	5

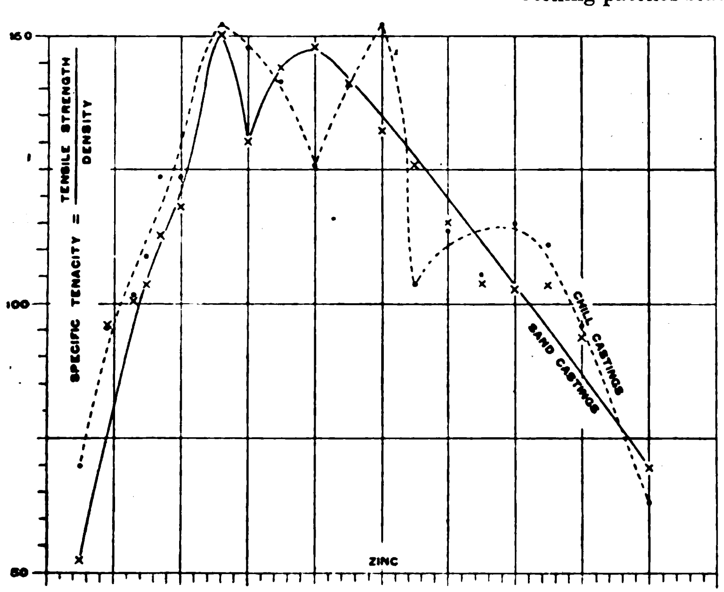

FIG. 19.

The tabulated data concerning the mechanical properties of the alloys containing zinc and copper, which have been given above, indicate that in all cases these alloys in the cast condition possess only a very small amount of ductility. No doubt this arises mainly from the cored structure which exists in the aluminium-zinc crystals, which form the bulk of these alloys. Once this cored structure has been removed, a very much increased ductility is obtained. A constitution of this kind, however, renders an alloy

very difficult to treat mechanically by such operations as forging and rolling. This difficulty exists mainly in the early stages of the operation, when the alloy still retains the comparative brittleness of the cast condition. It was, however, soon found that alloys containing as much as 25 per cent. of zinc and 3 per cent. of copper could be rolled. This was proved by the fact that occasionally a bar of these materials passed through the rolls successfully. So long, however, as experiments on these materials had to be carried out in an industrial plant, no regular success could be obtained. This was no doubt due to the fact that in an industrial plant the rolling conditions must be accepted as they are found. It is not possible as a rule to introduce any material variations in the speed and other characteristics of the rolls available. This consideration, coupled with a full recognition of the very great importance of the part which aluminium alloys were likely to play in the future, particularly in connection with aircraft construction, led to the establishment at the National Physical Laboratory of an experimental rolling mill. This experimental plant is illustrated in the photograph, Fig. 22. The installation consists of an electrically-driven two-high mill, in which flat rolls for rolling sheet metal and grooved rolls for rolling bars and rods can be used interchangeably. The rolls are 2 ft. 6 in. wide and 15 in. diameter.

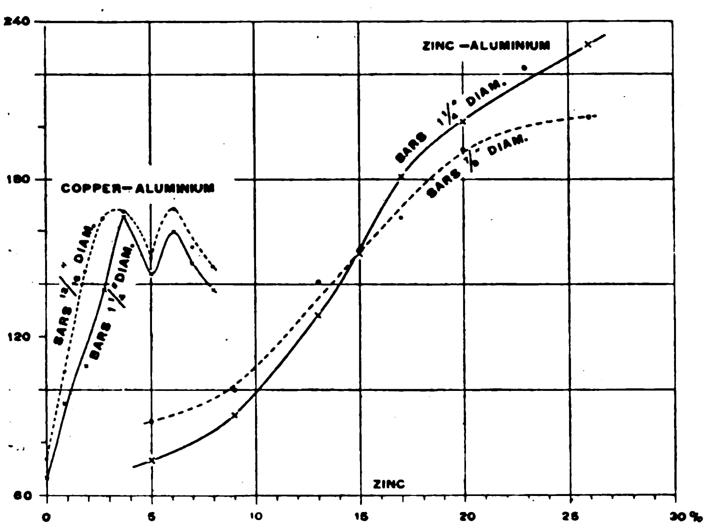

FIG. 20.

Even with this experimental plant, in which all the working conditions were readily controlled by the operator, it did not prove at first at all easy to roll certain of the alloys. Examples of the kind of failures which were obtained in the early efforts are shown in Fig. 23, where it will be seen that the alloys have undergone cracking in a variety of different ways. These difficulties and defects were, however, overcome by a careful study of the conditions under which they occurred. It may be interesting to point out that although many of them could be remedied by suitable adjustment of the conditions of rolling, heating, preliminary forging, etc., the most serious and fundamental difficulties could in nearly every case be traced back to the foundry where the original ingot had been prepared. The extensive experience which has been obtained in this connection, indicates very clearly that a very large percentage of all the defects which are met with in rolled metals generally are traceable to defects in the original cast material as it left the foundry.

As the result of the careful study of the conditions affecting these alloys, both in the foundry, the rolling mill, and in the annealing furnaces, the difficulties have been gradually overcome, and it is now possible to roll a range of materials, which, a few years ago, would have been regarded as quite outside the range of workable alloys. Not only this, but their rolling on a commercial scale has now been carried to such a degree of perfection that the loss by scrap can be kept negligibly small.

The physical properties of the hot-rolled material, as revealed by tensile tests, are shown in Table VII.

TABLE VII.—3 TO 20 ALLOY. TENSILE TESTS.

Condition.	Yield stress, tons per square inch.	Maximum stress, tons per square inch.	Extension, per cent. on 2 inch.
Rolled Rod, 7 to 8 in. diam.	18·8	26·0	20
Sheet, 18 gauge	21·6	26·2	18
	22·1	24·9	17
,, 26 ,,	20·6	27·6	19
	19·1	24·7	18

It will be seen that in this condition the alloys attain a very remarkable degree of strength and ductility, resembling that of mild steel. The tensile strength can be obtained as high as 26 to 27 tons per square inch, combined with an elongation on 2 in. of from 18 to 20 per cent.

The next step in the development of strong and light alloys has consisted in the addition of an element which imparts to them the property of undergoing hardening, which in some degrees resembles that of steel. The element mainly responsible for such a hardening property is magnesium, whose use in this connection was discovered by Wilm in Germany, some ten years ago. He applied it in the first instance to the alloys which were then regarded as the best possible wrought alloys of aluminium, namely, those containing copper and manganese, such as are referred to above. These had first been thoroughly investigated at the National Physical Laboratory here, and an account of them has been published in the Ninth Report to the Alloys Research Committee. The German proprietary alloy "Duralumin" is, therefore, to some extent a direct descendant of the alloys studied here some time previously. The properties of the material obtained by the addition of a small amount of magnesium to the copper-manganese-aluminium alloys referred to, are very remarkable. The material, when hot-rolled in the ordinary way, attains a tensile strength of not much more than 18 tons per square inch. If it is then heated to a temperature a little below 500° C. and quenched in water, its properties immediately afterwards are not very different from those of the annealed material. In the course of a few hours, however, the metal begins to undergo a change in properties. A hardening process occurs which gradually completes itself, at the ordinary temperature, in about four days. This process is represented diagrammatically in Fig. 24, in which Brinell hardness is the ordinate and time the abscissa. Typical properties of duralumin treated in this way are shown in Table VIII.

When the development of the rolled copper-zinc-aluminium alloys had reached the stage indicated above, it was natural to endeavour to effect further improvement by seeking to apply to them the hardening action of magnesium. This has been successfully done, and a series of alloys have been developed at the National Physical Laboratory which attain properties even more remarkable than those of "duralumin." Some additional difficulty in the manipulation of the material is brought about by the introduction of magnesium, but these difficulties have been overcome by careful experimental study. The properties of the resulting material, which has provisionally been called "high tensile" alloy, are shown in Table IX., p. 816.

The alloys have been prepared in various degrees of hardness, and the hardest and strongest of them can attain a tensile strength of 40 tons per square inch. There can be no doubt that these high tensile alloys represent a very considerable advance on the combination of

TABLE VIII.—DURALUMIN. TENSILE TESTS.

Material.	Yield stress, tons per square inch.	Maximum stress, tons per square inch.	Extension, per cent. on 2 inch.
Rolled Rod, 7 to 8 in. diam.	(1) 14·3	24·8	26
	(2) 16·5	25·6	28
Sheet, 18 gauge	14·0	26·7	21

(1) Cu = 3 per cent. (2) Cu = 4 per cent.

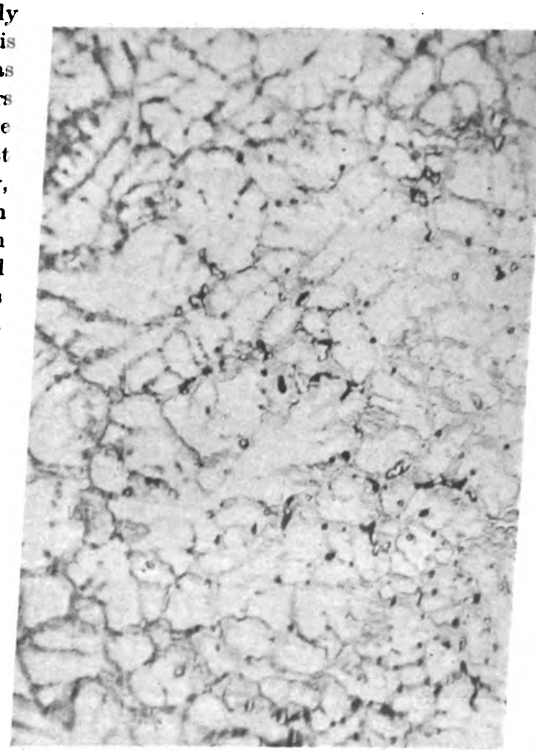

FIG. 21.

ALLOY OF ALUMINIUM WITH 20 PER CENT. ZINC AND 3 PER CENT. COPPER. CHILL CASTING.

Magnification by 100.

TABLE IX.

HIGH TENSILE ALLOYS. TENSILE TESTS.

Material.	Yield stress, tons per square inch.	Maximum stress, tons per square inch.	Extension, per cent. on 2 inch.
Rolled Rod, 7 to 8 in. diam.	32·9	37·8	11 6
Sheet, 18 gauge	30·1	36·0	14·5
SOFTER MODIFICATION.			
Rolled Rod, 7 to 8 in. diam.	26·0	34·0	20
Sheet, 18 gauge	30·1	34·6	13·5

strength and lightness which has yet been attained in aluminium alloys. That they are likely to find a very considerable degree of useful application appears probable. On the other hand, certain limitations must be recognised. It has, unfortunately, been found that alloys of aluminium containing both zinc and copper are peculiarly liable to corrosion, especially when exposed to contact with sea-water. When kept in the air in the ordinary way, they retain their bright surface almost indefinitely. Immersed in sea-water, however, they rapidly deteriorate. This property must be borne in mind when any attempt is made to put such alloys into practical service. Where they are not exposed to contact with sea-water, and where it is possible to protect them by a suitable coating of varnish or other protective material, no fear of undue corrosion need be entertained. Their physical properties are so remarkable that it is well worth while taking the trouble to ensure adequate protection from corrosion in order to avail ourselves of these materials.

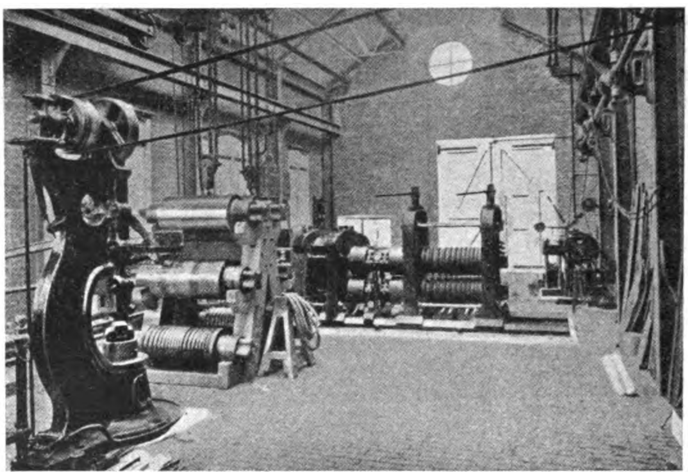

FIG. 22.

In view of the limitations just indicated, an endeavour has been made to find alloys, if possible as strong in proportion to their weight as the "high tensile" series, which shall be free if possible from the tendency towards corrosion, which the former alloys exhibit. Investigation with this end in view led to a study of the alloys in which nickel is present, as well as copper and magnesium. These researches, which were in the first place directed towards the production of a casting alloy having special strength at high temperatures, have led to the development of a type of material which possesses very marked advantages. The tensile strength, even after hardening and ageing, is not as high as that of the "high tensile" series, although it may be hoped that future developments will lead to improvement in that direction. On the other hand, these alloys retain their strength at a higher temperature than any other wrought alloys of *aluminium*, and exhibit a very marked resistance to corrosion, even when in contact with sea-water. Typical of this group of alloys is one containing 4 per cent. of copper, 2 per cent. of nickel, and 1½ per cent. of magnesium, the remainder being aluminium. The properties of this alloy are shown in Table X., but it should be remarked that these figures represent conservative estimates of the results obtainable with this alloy. Since the data given

TABLE X.—4/2/1·5 ALLOY. TENSILE TESTS.

Condition.	Yield stress, tons per square inch.	Maximum stress, tons per square inch.	Extension, per cent. on 2 inch.
Sand cast, 1 in. dia.	7·9	11·1	1·5
Chill „ „	9·2	12·7	1·5
Rolled Rod, 7 to 8 in. dia.—			
As rolled	12·0	18·0	19
Heat-treated	14·3	24·0	24
Sheet—			
As rolled	22	24·5	3
Heat-treated	17·2	23·3	17

in the above Table were prepared, the alloy has been regularly produced with a tensile strength as high as 27 tons per square inch.

The use of nickel in these alloys offers a point of remarkable interest. Usually it is found that

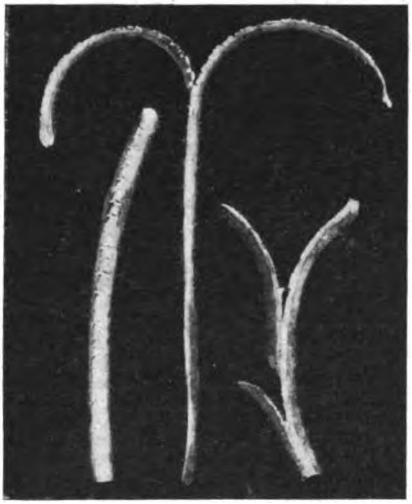

FIG. 23.

the addition of another element to an alloy, already sufficiently hard to be difficult to roll, renders it completely unsuitable for working. The addition of nickel to the copper alloys, however, appears to have precisely the opposite effect. Thus the addition of 2 per cent. of nickel to an alloy already containing 8 per cent. of copper, instead of rendering that alloy harder and more difficult to handle, renders it distinctly easier to roll; in fact, the alloy cannot be rolled in the absence of the nickel, but can be rolled with considerable ease when 2 per cent. of nickel has been added. It would appear that

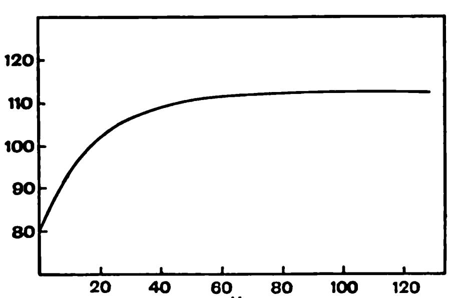

FIG. 24.

this action of nickel is due to the formation of a ternary compound of copper aluminium and nickel, which is less brittle than the binary aluminium-copper compound. This matter, however, is being investigated, and offers very considerable difficulties, so that a definite statement cannot yet be made.

The present lecture may be concluded by a comparison of the various wrought alloys which have been described. Such a comparison is best made in terms of their specific tenacities, and a Table giving the values of their specific tenacities in the ordinary units, and also in terms of miles of lengths of material which can just support their own weight, are given in Table XI.

TABLE XI.

$$\text{Specific Tenacity} = \frac{\text{Max. stress (tons per sq. in.).}}{\text{Weight of 1 cu. inch (lbs.).}}$$

Alloy.	Condition.	Specific tenacity.	Miles supported vertically.
3 to 20	Rolled, 29 tons per sq. in.	262	9
Duralumin	Rolled, 27 tons per sq. in.	268	9
H. T.	Rolled, 39 tons per sq. in.	360	12·6
Steel	Rolled, 30 tons per sq. in.	105	3·7

[Figures 13, 17, 18, 19, and 20, are taken from the Tenth Report to the Alloys Research Committee of the Institution of Mechanical Engineers by Rosenhain and Archbutt (1912); Figure 23 originally appeared in the *Journal* of the West of Scotland Iron and Steel Institute, April, 1916. Permission to reproduce the figures has kindly been granted by the authorities of these two bodies.

CORRECTIONS IN LECTURE I.

In Table I. (page 798, column 1) for "*Cast.* 1 in. diameter. Chill shaped sand," read "*Cast.* 1 in. diameter Chill. Shaped sand"; for "*Rolled.* Rod 13–16 in. diameter," read "*Rolled.* Rod $\frac{13}{16}$ in. diameter"; and for "*Drawn.* Rod 13–16 in. diameter," read "*Drawn.* Rod $\frac{13}{16}$ in. diameter."]

GENERAL NOTES.

THE NEWCOMEN SOCIETY.—This society has been founded to encourage the study of the history of engineering and technology. Its principal objects are: (1) To disseminate historical information among its members by meetings, intercourse, discussion, correspondence, circulation of notes and papers, and visits to objects and places of interest. (2) To act as a channel of communication between members who are engaged on similar lines of research or study; to indicate, as far as possible, where information is to be found. (3) To collect

and preserve or cause to be preserved, locally or nationally, examples, records, manuscripts, drawings and illustrations of, or relating to, engineering work and industrial processes. (4) To collect and preserve in a similar way biographical matter concerning those men who have contributed to engineering or industrial progress. (5) To publish in a form, and at a date to be determined, a journal containing original memoirs by members and historical material not generally accessible. (6) To form, by collaboration among its members, a card index of published information on the historical aspect of engineering and technology. (7) To do all such acts as shall lead to active corporate life of the society. Further particulars as to membership, etc., can be obtained from the hon. secretary, Mr. H. W. Dickinson, the Science Museum, South Kensington, S.W. 7.

American Commercial Activity.—When H.M. Senior Trade Commissioner in Canada and Newfoundland was in the latter country a few weeks ago, some thirty representatives of American manufacturers were visiting this progressive British possession and only two representatives of United Kingdom manufacturers. "I hope," he writes, "this fact will act as a stimulant, and not as a deterrent, to the United Kingdom manufacturer, as it shows that there must be a great quantity of business to be obtained, otherwise all these men would not be there, and I confidently assert that British goods and British manufacturers will always have the preference." One point that impressed the Commissioner is that many United Kingdom manufacturers insist on treating Newfoundland as part of Canada, instead of realising that it is a separate self-governed territory. These manufacturers try to transact their Newfoundland business through their Canadian agents or houses, a procedure which by no means meets with the approval of Newfoundland buyers, and is the cause of a very considerable loss of business to us.

MEETINGS FOR THE ENSUING WEEK.

Monday, November 15 ... Pottery and Glass Trades' Benevolent Institution, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Dr. M. W. Travers, "Glass in Connection with the Lamp Blown Glass Trade." (Lecture II.)

Botanic Society, Inner Circle, Regent's-park, N.W., 3 p.m. Professor A. W. Bickerton, "The Relations of Astronomy to Botany." (Lecture I.)

Automobile Engineers, Royal Technical College, Glasgow, 7.30 p.m. (Scottish Section.)

Geographical Society, Kensington Gore, W., 5 p.m. Professor H. E. Schwarz, "The Control of Climate by Lakes."

British Architects, Royal Institute of, 9, Conduit-street, W., 8 p.m. Mr. R. Dircks, "The Library of the Royal Institute of British Architects."

Tuesday, November 16...Petroleum Technologists, Institution of, at the Royal Society of Arts, John-street, Adelphi, W.C., 5.30 p.m. Mr. L. W. Bates, "Colloidal Fuel."

Metals, Institute of (Birmingham Section), Imperial Hotel, Temple-street, Birmingham, 7.30 p.m. Discussion on "Hardness in Non-Ferrous Alloys."

Statistical Society, 9, Adelphi Terrace, W.C., 5.15 p.m. Sir R. Henry Rew, Presidential Address.

Roman Studies, Society for the Promotion of, at the Society of Antiquaries, Burlington House, W., 4.30 p.m. Mr. G. H. Stevenson, "Some New Light on the Franchise Question."

Civil Engineers, Great George-street, S.W., 5.30 p.m. Mr. F. W. Macaulay, "Cross Connections on the Elan Aqueduct of the Birmingham Corporation Waterworks."

British Decorators, Institute of, Painters' Hall, Little Trinity-lane, E.C., 7.30 p.m. Major F. C. Wheeler, "Smoke Abatement and its Remedies from a Decorators' Point of View."

Colonial Institute, Hotel Victoria, Northumberland Avenue, W.C., 4 p.m. Mr. W. S. Bromhead, "Kenya Colony: its Present Prospects and Future Development."

Electrical Engineers, Institution of (North Midland Section), Hotel Metropole, Leeds, 7 p.m. Mr. C. J. Jewell, "Chairman's Address."

Zoological Society, Regent's Park, N.W., 5.30 p.m. 1. The Secretary, "Report on the Additions to the Society's Menagerie during the month of October." 2. Dr. W. A. Cunnington, "The Fauna of the African Lakes; a Study in Comparative Limnology, with special reference to Tanganyika." 3. Mr. H. F. Carter, "Descriptions of the Adult, Larval and Pupal Stages of a new Mosquito from Lord Howe Island, South Pacific." 4. Dr. C. L. Boulenger, "Filariid Worms from Mammalia and Birds in the Society's Gardens, 1914-1915."

Wednesday, November 17...Royal Society of Arts, John-street, Adelphi, W.C. 2, 8 p.m. Opening Meeting of the 167th Session. Address by Mr. Alan A. Campbell Swinton, "Wireless Telegraphy and Telephony."

Meteorological Society, 70, Victoria-street, S.W., 8 p.m. 1. Messrs. C. E. P. Brooks and H. W. Braby, "The Clash of the Trades in the Pacific." 2. Dr. W. H. Steavenson, "Note on the Mirage, as observed in Egypt."

Geological Society, Burlington House, W., 5.30 p.m.

United Service Institution, Whitehall, S.W., 5.30 p.m. Colonel John Ward, "Labour and its Relations to the Army."

Thursday, November 18 ... Aeronautical Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 5 p.m. Mr. H. B. Irving, "The Design of Aeroplane Control Surfaces, with special reference to Balancing."

Wireless Society, at the Royal Society of Arts, John-street, Adelphi, W.C., 8 p.m. Address by Mr. Alan A. Campbell Swinton.

Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Address by the president, Mr. L. B. Atkinson.

Child Study Society, at the Royal Sanitary Institute, 90, Buckingham Palace-road, S.W., 6 p.m. Dr. F. G. Crookshank, "The Anthropological Study of the Feeble-Minded, or Imbeciles and Apes."

Chromatics, International College of, Caxton Hall, Westminster, S.W., 8 p.m. Miss E. G. Kemp, "The Flowers and Flowery Tribes of Kweichen China."

Linnean Society, Burlington House, W., 5 p.m. 1. Professor E. S. Goodrich, "A new type of Teleostean cartilaginous Pectoral Girdle found in young Clupeids." 2. Dr. J. C. Willis, "Endemic genera and species of Plants."

Numismatic Society, 22, Russell-square, W.C., 6 p.m.

Mining and Metallurgy, Institution of, at the Geological Society, Burlington House, W., 5.30 p.m.

Friday, November 19...Mechanical Engineers, Institution of, Storey's-gate, Westminster, S.W., 6 p.m. Captain J. S. Arthur, "Sterilization of Water by Chlorine Gas."

Electrical Engineers, Institution of (Student's Section), at the City and Guild's College, Exhibition Road, S.W., 7 p.m. Mr. C. C. Paterson, "The Incandescent Electric Lamp from the Inside."

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No. 3,548. VOL. LXVIII.

FRIDAY, NOVEMBER 19, 1920.

All communications for the Society should be addressed to the Secretary, John Street, Adelphi, W.C. (2)

NOTICES.

NEXT WEEK.

WEDNESDAY, NOVEMBER, 24th, at 8 p.m. (Ordinary Meeting). Dr. F. W. EDRIDGE-GREEN, C.B.E., F.R.C.S., Special Examiner in Colour Vision and Eyesight to the Board of Trade, "Colour Vision and Colour Blindness." SIR PHILIP LLOYD-GREAME, K.B.E., M.C., M.P., Parliamentary Secretary to the Board of Trade, in the Chair.

FIRST ORDINARY MEETING.

The Opening Meeting of the 167th Session of the Society was held on Wednesday, November 17th, when an experimental address on "Wireless Telegraphy and Telephony" was delivered by Mr. ALAN A. CAMPBELL SWINTON, F.R.S., Chairman of the Council.

A full report of the meeting will be published in the *Journal* of December 3rd.

ARRANGEMENTS FOR THE SESSION 1920-21.

Particulars of the arrangements for the forthcoming session, so far as they are at present completed, have been posted to all Fellows of the Society. Any Fellows who have not yet received them are requested to communicate with the Secretary.

CASES FOR JOURNALS.

At the request of several Fellows of the Society, cases have been made for keeping the current numbers of the *Journal*. They are in red buckram, and will hold the issues for a complete year. They may be obtained, post free, for 7*s*. 6*d*. each, on application to the Secretary.

PROCEEDINGS OF THE SOCIETY.

CANTOR LECTURES.

ALUMINIUM AND ITS ALLOYS.

By W. ROSENHAIN, D.Sc., F.R.S.

Lecture III.—Delivered April 26th, 1920.

Having in the previous lecture described the outstanding properties of the more important alloys of aluminium so far as they have been developed, we have now to consider the various uses to which these alloys have been put or can be put. It must be borne in mind at the outset that at the present time aluminium and its alloys must be regarded as relatively expensive material. Their use will therefore be confined to those cases where lightness is of considerable importance, and where the question of cost does not enter so strongly into consideration. This consideration of lightness has undoubtedly been responsible for the very great development which has occurred in the application of aluminium alloys to engineering uses during the war. Their use for all kinds of aircraft naturally occurs to one, but in addition to those uses the alloys have also been employed in very large quantities in automobile construction and also in tanks and in the engines of submarines. While the necessities of war have thus afforded an unprecedented incentive to develop the aluminium alloys and their applications, it should be borne in mind that very extensive fields of usefulness for peaceful industrial purposes also exist. Here the question of price becomes of much greater importance, and the real future of the aluminium industry and of the industry connected with the production of all kinds of aluminium alloys must depend upon a reduction in price of aluminium itself.

The various uses to which aluminium alloys have been and can be put group themselves naturally into two divisions according as castings or wrought material have to be employed in each case. We shall deal first with the question of castings, and these again may be subdivided into two groups—namely, the first group which are used in situations where they are not exposed to high temperatures, and the second group those in which exposure to high temperatures is essential.

In regard to castings of the first group, crank cases for aero engines, automobile engines, and many other purposes, may be taken as an example. Reference to the data given in the second lecture will show that a large number of different alloys are available for such

uses. These include the aluminium-copper, the aluminium-copper-manganese, and the aluminium-zinc-copper alloys. At an early stage of the war, the National Physical Laboratory was asked to advise the Air Ministry, or its then equivalent, as to the choice of the best aluminium alloy for this purpose. In making this choice a number of considerations had to be taken into account. In the first place the highest possible strength was desirable in these castings, but it had to be coupled with reasonable ease of casting and reasonable safety in the manipulation of the casting while hot. In order to obtain the desired strength, it was thought desirable to employ aluminium-copper-zinc alloys, but at the same time it was evident that it would be desirable to keep the density of the alloy as low as possible consistent with adequate strength, since very thin sections could not be used in such castings, and therefore the very high strength of the denser alloys could not be fully utilised.

The specification ultimately suggested was for an alloy containing from 12 to 15 per cent. of zinc and about 2½ per cent. of copper. This is far from being the strongest of the alloys of the zinc-copper aluminium series, but it combines the various properties required in what was believed to be the best possible degree. For the purpose of comparing it with other well-known casting alloys, Table XII. has been drawn up in which the tensile properties of this alloy, which is generally known as "L 5," are compared with those of the alloys containing 12 per cent. and 4 per cent. of copper respectively.

TABLE XII.—ALL TESTS ON 1-INCH DIAM. ROD.

Alloy.	Yield stress, tons per square inch.	Ultimate stress, tons per square inch.	Elongation, per cent. on 2 inches.
Alloy—			
"L 5" sand . .	6·0	9·3	2
Chill	8·2	13·4	5
12 per cent. Copper—			
Sand	5·0	7·9	1
Chill	6·4	9·7	1·5
4 per cent. Copper—			
Sand	4·9	7·5	5
Chill	5·4	9·6	11

When the "L 5" alloy came to be manufactured on a large scale, some peculiarities were met with. It was found that results which had been obtained at the National Physical Laboratory some years ago could not be readily reproduced in the works, and an attempt to reproduce them in the Laboratory also failed at first. It was then discovered that these alloys undergo a gradual ageing process which leads to an improvement in their tensile strength. Tests made on samples some months old therefore give higher results than those made on freshly cast test pieces, and this difference accounted at once for the discrepancies which had been found. The effect of this ageing is an increase generally of the order of two or three tons per square inch in the tensile strength. The ductility of these alloys is so low that any change in that respect can scarcely be traced.

In considering the values of various casting alloys, these ageing effects must be taken into account. In addition, however, some of the alloys are capable of being very considerably improved by heat treatment. Thus the alloy containing 4 per cent. of copper, remainder aluminium, is capable of being very much improved in mechanical properties by a prolonged annealing process. The object of this annealing process is to bring into solid solution as much as possible of the aluminium-copper compound, which in the ordinary cast condition is present in the alloys as a separate constituent. In the case of an ordinary chill cast test piece, this appears to require heating at a temperature from 450° C. to 520° C. for three days. As the result of this treatment, however, the tensile strength of the alloy is increased from 10 tons per square inch to 14·5 tons per square inch, while the elongation per cent. on two inches is increased from 10 per cent. to 20 per cent. This is, of course, a very remarkable improvement, but, unfortunately, heat treatment of so prolonged a period as three days appears to be expensive and may be difficult to apply in practice.

We turn now to consider the second group of castings for which light alloys are required—namely, those which are exposed to high temperatures. Among these, pistons for aero engines, and also for other engines such as those used in tanks and submarines, constitute a most important group. At first sight it would seem that the obvious reason for using aluminium alloy pistons in internal combustion engines lies in the lightness of the metal and the consequent saving in weight of the engine. In the case of very large and heavy engines, such as those of submarines, this no doubt is the main reason for their use, and from this point of view they have proved particularly successful. On the other hand, in aero engines

and in others where it is important to develop a maximum of power with a minimum of weight and petrol consumption, the use of the aluminium alloy pistons is justified from quite a different point of view. In these engines, in fact, the pistons when made of aluminium alloys are frequently made so much thicker in section that no saving in weight as compared with steel pistons is obtained. What is obtained, however, is a very important thermal effect. The thermal conductivity of pure aluminium is of the order of 0·52 as compared with 0·11 of cast iron. The aluminium alloys which are suitable for use as pistons do not quite attain the high thermal conductivity of the pure metal, but many of them attain a value greater than 0·40. Thus the heat-conducting power of an aluminium alloy piston is of the order of four times that of an iron piston of the same dimensions, and if the thickness of the piston can be increased in consequence of the lighter weight of the metal, the heat-conducting power is further augmented. The advantage from the point of view of the high-duty engine lies in the fact that with a piston having this high thermal conductivity, a greater ratio of compression can be used without leading to pre-ignition. The application of this increased compression, together with other subsidiary advantages which are obtained from the use of the aluminium pistons, has led to an economy which, in some engines, has meant an increase of power of the order of 20 per cent. as compared with the same engine working with an iron or steel piston. At the same time an important decrease in petrol consumption per horse-power hour has also been obtained. The importance of such a result from the point of view of aircraft can hardly be overrated, so that some of the disadvantages and troubles which are still met with owing to the imperfections of aluminium alloy pistons, are outweighed by the very substantial advantages which they offer.

In considering the question of the alloy to be used in the construction of an aluminium alloy piston, the temperature to which such pistons are exposed in service becomes a matter of vital importance. Unfortunately it is not easy to obtain exact and reliable data on this point. Some measurements which have been made by Dr. Gibson at the Royal Aircraft Establishment suggested that the maximum temperature does not exceed 250° C.

Some purely metallurgical evidence which has been obtained in my own laboratory tends to confirm this view, as specially prepared specimens of metal inserted in some of these pistons did not show a change of internal structure which would undoubtedly have occurred on exposure to temperatures markedly higher than 250° C. On the other hand, the view is strongly held in some quarters that pistons in aero engines sometimes attain a temperature sufficient to lead to the actual fusion of the aluminium-copper eutectic, and this would indicate a temperature exceeding 530° C. It seems, however, from the nature of the alloys which have been more or less successfully used in such pistons, that the attainment of these temperatures must be exceptional.

A working temperature in the neighbourhood of 250° C., however, represents a set of conditions very different from those applicable to a casting working at the ordinary temperature. The majority of aluminium alloys are found to lose their strength very rapidly with increasing temperature. This is the case to a surprising extent with all the alloys containing any appreciable quantity of zinc, and therefore alloys of that type and of the zinc-copper type must be excluded from use for pistons.

A long series of experiments were carried out at the National Physical Laboratory on the behaviour of various types of aluminium alloys under tensile tests at high temperatures, and these were confirmed by other workers, both at the Royal Aircraft Establishment, Farnborough, and in Professor Lea's laboratory at Birmingham. It would occupy too much space to go into details of all these tests, but in Fig. 25, a series of graphs are given representing the tensile properties at various temperatures of five alloys. These include, in the first place, the "L 5" alloy, containing copper and zinc, which is seen to deteriorate very rapidly with rising temperature. We next have the alloy containing 12 per cent. of copper alone, and also an alloy which has proved very successful, up to a certain point, which has been developed at the Royal Aircraft Establishment. This contains 7 per cent. of copper, 1 per cent. of zinc, and 1 per cent. of tin. All these alloys, in varying degrees, show a decline of tensile strength with rising temperature, although the two high copper alloys do not fall off so rapidly as the alloy containing zinc. The next alloy to be considered is one containing 14 per cent. of copper and 1 per cent. of manganese. This alloy, first developed at the National Physical Laboratory, shows the remarkable property that, up to a temperature of 250° C., the tensile strength of castings increases instead of

decreasing. Unfortunately this alloy proved somewhat difficult to cast, and was regarded as unduly brittle. Development was further hindered by the fact that, in the condition as cast, its thermal conductivity is distinctly lower than that of some of the others. Subsequent work has shown, however, that the reputation of this alloy for brittleness is scarcely well founded, while the thermal conductivity can be brought up to the level of that of the other alloys by a short period of annealing after casting. Some experimental pistons of this alloy have worked quite satisfactorily, and once aluminium founders have learnt to overcome the peculiarities of this material in casting, there is little doubt that it would prove a satisfactory and successful alloy for pistons. The last alloy on the diagram is that containing both copper and nickel (4/2/1½), to which reference has been made in the previous lecture. This alloy shows higher tensile properties at all temperatures up to 250° C. than any of the others, and would therefore appear to be eminently suited for use in pistons. It was unfortunately only developed quite shortly before the close of the war, and therefore its adoption in practice was never carried out. It seems probable, however, that there is a very great future for this particular material, or at all events, for alloys of that type.

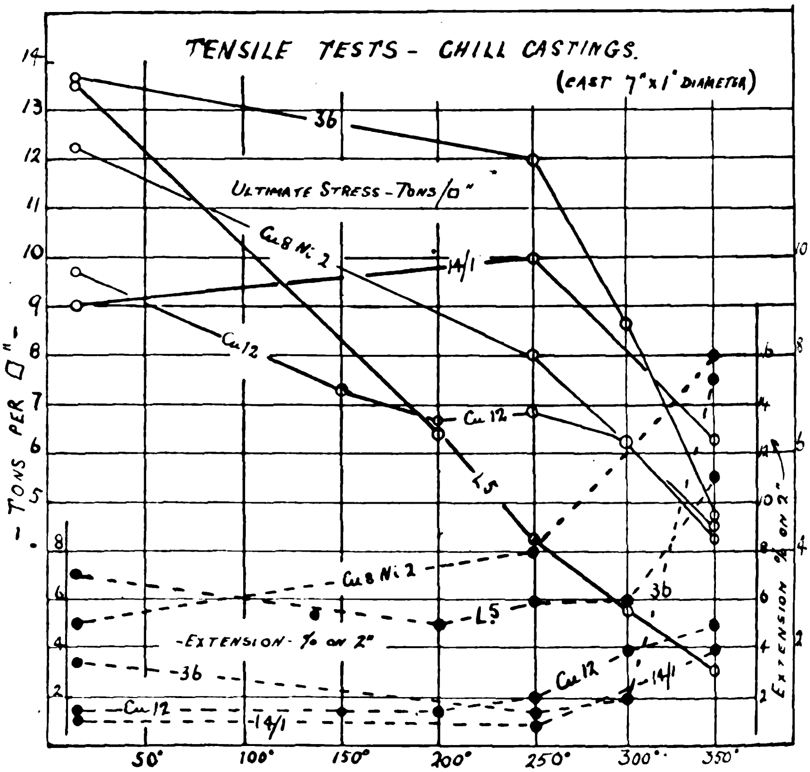

FIG. 25.

Although aluminium pistons on the whole have proved eminently successful in aircraft engines, a certain amount of trouble has been experienced with them. In many cases this is no doubt due to failures of lubrication and similar defects. On the other hand, a whole class of cases of failure have been observed which are grouped under the name of "burning" of pistons. A burnt piston shows a roughened surface which is sometimes deeply eroded, and in some cases, where the defects have gone very far, the piston may be entirely pierced at one point of its head. The exact nature of the action which takes place in these cases has not yet been fully elucidated. In some quarters it is thought that it is simply a question of the local fusion of the aluminium-copper eutectic and its expulsion, followed by the disintegration of the whole metal. If this is the case, the remedy lies in the use of alloys containing a smaller amount of the aluminium-copper compound. A more fundamental explanation seems to be, however, that, since alloys of the 12 per cent. copper type, or of the

type containing 7 per cent. of copper, 1 per cent. of zinc, and 1 per cent. of tin have been so widely used for aero engine pistons, these pistons have been made of alloys not quite strong enough for their purpose at the temperatures to which they are exposed. This argument has been strenuously resisted by those who were anxious to avoid any change in the type of alloy used. There is, however, every hope that the adoption of alloys of the 4/2/1½ type will to a large extent eliminate the trouble from burnt pistons.

A number of other special points have to be considered in regard to the use of aluminium alloy pistons, both in aircraft and in other engines. In the first place it must be borne in mind that the thermal expansion of the aluminium alloys is very much greater than that of iron or steel. The actual comparison is 26 in the case of the aluminium alloys, as compared with 10 in the case of steel. This implies the necessity for a considerably greater amount of clearance between the piston and the cylinder when cold than is necessary where both piston and cylinder are made of iron or steel. This clearance is, of course, taken up when the engine becomes heated, owing to the greater expansion of the aluminium, but it is liable to lead to a certain amount of looseness and noise, due to what is known as "piston-slap," when the engine is first started.

Quite apart from this question of thermal expansion, which is, of course, temporary and reversible when the piston cools down again, a good deal has been said on the subject of the supposed "growth" of aluminium castings when heated and cooled alternately. Such growth is quite a different matter from thermal expansion, since the growth would be irreversible and would lead to a permanent increase in the size of the casting. Careful measurements of this growth in piston castings have been made, and the results of these show that it is a very small matter indeed as compared with thermal expansion. In the case of a casting whose thermal expansion amounted to ·0026 in., the permanent growth amounted to only ·0004 in. In any case, careful previous annealing of the casting will prevent such growth entirely, and it seems that altogether undue importance has been attached to it.

Finally, reference may be made to the question of the manner in which the gudgeon-pin can be made to work in an aluminium alloy piston. In the ordinary practice, steel or iron bushes are provided, and these are cast into the piston casting. This is a fairly satisfactory arrangement, but it has been suggested that the provision of an iron bush is unnecessary, and that it is perfectly satisfactory to allow the gudgeon-pin to work direct in the aluminium casting. Here a great deal must depend upon the character of the casting itself, that is, whether the alloy is strong enough to take the pressure of the gudgeon-pin direct. In the better types of piston alloys now available, this is probably the case. The question of the manner in which an aluminium alloy will act as a bearing metal also arises to some extent, although if the gudgeon-pin is free in the connecting-rod and the piston, the bulk of the movement may be arranged to take place as between the gudgeon-pin and the connecting-rod. Actual experiments on aluminium alloy bearings, however, have shown that these offer considerable promise of satisfactory behaviour, so that from this point of view, also, it may be possible to dispense with iron bushes.

Another type of casting, which is also to some extent exposed to high temperatures, are the cylinder and cylinder blocks of aero engines. In the case of water-cooled engines, these are not exposed to anything like the temperatures which occur in the case of pistons, because the temperature of the cylinder casting is kept low by the circulating water, while the surface in contact with the exploding gases in the engine is generally provided in the shape of a steel liner. In air-cooled engines, however, even although a liner is still provided, the aluminium casting is liable to attain a considerable temperature, and power to withstand that temperature is necessary. In most cases, however, the castings required for cylinder purposes are of a very complicated character, involving a large amount of coring and somewhat difficult casting problems generally. In these circumstances alloys have generally been selected from the point of view of providing the greatest possible facilities to the founder, rather than from the point of view of securing the best possible physical properties for the engine. None the less, from the point of view of saving weight mainly, cylinder castings of aluminium alloys have proved very successful. (A number of examples of such castings, as well as of pistons, and other aluminium alloy products, were kindly lent for exhibition at the lectures by the Birmingham Aluminium Castings Co. and Messrs. Wolseley Motors, Ltd.)

From the thermal point of view, however, the effect of substituting an aluminium alloy casting

for the ordinary cast iron cylinder of an aero engine has been distinctly disappointing. The effect of the aluminium pistons in assisting in the removal of heat from the compression space of the engine having proved so very valuable, it was naturally hoped that similar high thermal conductivity in the cylinder walls would assist to a corresponding extent. Actually this has not been found to occur, and the gain in power and economy from the use of aluminium alloy cylinders has been comparatively small. To some extent this is probably due to the fact that a steel liner is usually interposed between the piston or the cylinder proper and the aluminium casting. The necessity for providing the interior of the cylinder with an iron or steel surface to take the wear of the piston is at the present time universally admitted. An engine has been run in which an aluminium alloy piston worked directly in a cylinder cast in the same material, but it is doubtful whether anyone would care to trust to the reliability of an engine constructed in that manner.

Unfortunately the behaviour of a steel liner inside an aluminium alloy casting is in many ways unsatisfactory. Owing to the fact that the aluminium casting expands much more rapidly with rising temperature than the liner itself, there is a tendency for the casting to expand out of contact with the liner. The result must be the development of a thermal discontinuity between the steel liner and the aluminium casting. This will result in a rise of temperature of the liner which will continue until the increased expansion of the liner, consequent upon such an additional rise of temperature, again brings it into approximate contact with the casting. The engine will therefore run, ultimately, in a condition of equilibrium, in which the temperature of the liner is considerably higher than that of the inner face of the aluminium alloy casting. Were it possible to provide the internal surface of an aluminium alloy cylinder with a hard wearing layer suitable for forming a cylinder wall and taking the wear of the piston, these disadvantages would be overcome. Apart from the question of temperature attained, however, there can be no doubt that the high thermal conductivity of the cylinder castings made in aluminium alloys has proved of considerable advantage in aero engines, particularly in the case of air-cooled engines. In these, when running at high powers, there is a strong tendency for distortion of the cylinders to take place, owing to the fact that the leading side of the cylinder in a rotary engine, or the forward side in a stationary engine, is better cooled by contact with the air than the other side. The result is an unequal expansion and a distortion of the cylinder which leads to bad fitting of the piston. The high conductivity of the aluminium alloy casting, however, equalises the temperature all around the cylinder in a much more satisfactory manner, and enables it to retain its circular section, thus preserving the efficiency of the piston.

Owing to the disappointing thermal results already indicated, aluminium alloy castings for cylinders have not found universal adoption even in aero engines. On the other hand, aluminium alloy cylinder heads have been widely used, and these can be employed without any lining, owing to the fact that they are not exposed to frictional contact with the pistons. Such cylinder heads, however, have to be provided with openings and seatings for the valves, and these again cannot be allowed to work direct on the aluminium alloy. As a rule this has been met by casting into the cylinder head casting suitable rings of steel to serve as valve seatings. In some cases these cast-in pieces have given a certain amount of trouble, but on the whole they can be used satisfactorily.

The question naturally arises whether other engine parts, particularly in aero engines, could not be made of aluminium alloys, and in this connection it is thought that a considerable field for the use of wrought, that is, rolled aluminium alloys may be opened up. In the first place there are a large number of bolts and nuts in all aero engines, and in the aggregate the weight of these bolts and nuts when made in steel is very considerable. Their replacement by "duralumin" or "high tensile" alloys would undoubtedly effect a considerable saving. On the other hand, it must be borne in mind, that, for these purposes, special steels having a very high tensile strength can be used.

A much more interesting but also more difficult problem is the possible use of aluminium alloys for connecting rods. These are exposed to very severe alternating stresses, and at the same time, at one end at all events, they are also exposed to a high temperature. With a view to ascertaining the best alloy for this purpose, a series of alternating stress tests at high temperatures have been carried out. As a result it has been found that the best alloy for such a purpose is undoubtedly the "4 2 1½" type containing copper, nickel and magnesium.

Duralumin is found to come next in order of merit for this purpose, so far as alternating stress tests have indicated. There is, however, considerable difficulty in finding room for somewhat larger connecting rods in many engines, yet such an increase in size is probably essential if wrought aluminium alloys are to be used for that purpose. The development of a light alloy connecting rod for aero engines and possibly for automobile engines generally, is therefore a matter which still lies in the future, although it is a development which is to be anticipated at an early date.

In our discussion of the use of light alloys in aero engine construction, we have already departed from the range of castings and entered the field in which wrought alloys have to be used. This transition has to be made still more completely when we come to consider the material required for structural use in aircraft, both in aeroplanes and the larger and more imposing rigid airships. In the construction of rigid airship frames particularly, there is a large field for the use of wrought aluminium alloys in the form of rolled channels, stampings, and other forms. Hitherto, following the model of the German airships, these have all been made of duralumin. Some of the data now available show, however, that other alloys deserve the most careful consideration for these purposes.

The properties required in the construction of rigid airship girders are obviously the maximum combination of strength with lightness. The form of strength required, however, is not mainly tensile strength, since failure in these complicated structures generally takes place by some form of buckling under a compression stress. (A number of examples of girders from rigid airship construction were exhibited at the lecture, a photograph of one of these is shown in Fig. 26.) The girders of the rigid airship are most liable to fail by buckling under compression, and such buckling may occur either in the girder as a whole, or in any small part of it. In order to ascertain the comparative behaviour of various alloys when rolled into the form of channel sections, such as are used in airship construction and exposed to compression stresses, a series of buckling tests have been carried out, using lengths of 6 in.

The results are given in Table XIII., where it will be seen that the new alloys show very considerable advantages over duralumin. The examples shown (at the meeting) of actual portions of girders constructed of these alloys,

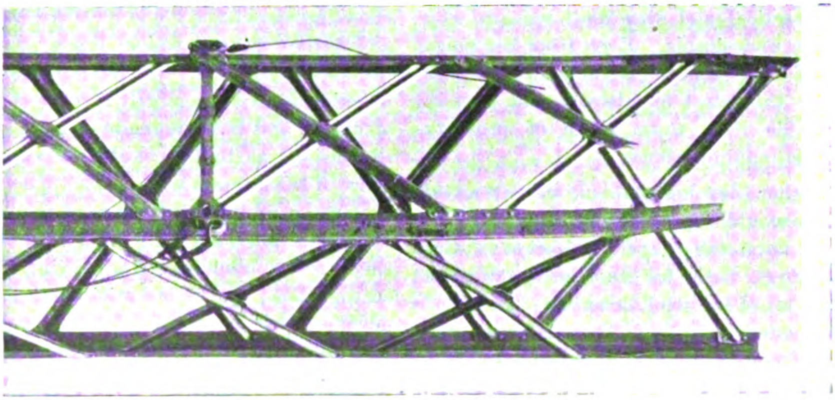

FIG. 26.

TABLE XIII.—COMPRESSION TESTS ON "C" TYPE CHANNELS.

Selected channels ·048 thick.

Six-inch lengths taken and ends "squared off" parallel to each other, and at 90° to C.L. of channel.

Tested with free ends between ball centres at centre of gravity of channel.

Length between ball centres, 7¼ inches.

Area, ·089 square inches.

Alloy.	Load tons.	Buckling stress, tons per square inch.
4/2/1½ alloy	1·171 1·259	13·20 14·16
Duralumin (Vickers)	0·992 1·161	11·15 13·07
3/20 alloy	1·469 1·601	16·50 18·02
H.T. alloy "G"	1·629 1·719	18·31 19·32
H.T. alloy "F"	1·862 2·130	20·97 23·90
H.T. alloy "E"	2·020 2·100	22·72 23·62

are sufficient to prove that the materials are quite capable of being produced and worked up into the condition required for these types of construction.

In the construction of all-metal aeroplane wings also, there is a field for light alloys. At the present moment an effort is being made to prove that high tensile steel can be used with advantage in comparison with aluminium alloys. In view of the fact that the specific tenacities of the aluminium alloys are considerably higher than those of the best steels, this does not appear to be a correct solution. There is a further fact to be remembered, that in the use of a very strong but relatively heavy material like high tensile steel it will be necessary to employ it in extremely thin sections. There are obvious practical and structural reasons why this is very undesirable. Even from the point of view of corrosion, it is doubtful whether these very thin steel members would be any more reliable than those made of properly protected aluminium alloys.

The further development of the all-metal aeroplane would appear, therefore, to be dependent upon the proper utilisation of aluminium alloys, both for the construction of the spars and of the wing covering. The most obvious tendency to be followed in an all-metal construction would seem to be the replacement of the wooden spars and ribs and of the fabric covering by corresponding parts made of aluminium alloys. Considerable success has already been achieved in that direction, light alloy wing spars of strength and reliability at least as great as the best wooden spars have been produced and tested. With regard to the wing covering replacing fabric, it has been found possible at the National Physical Laboratory to roll down some of the strongest aluminium alloys into very thin sheets whose weight per square yard is not greater than that of doped fabric. This very thin sheet has a thickness of the order of ·003 in., and therefore presents considerable difficulty both in course of manufacture and in handling. The actual problem of attachment has been solved by a particular device which allows of the tightening of such metallic fabric by satisfactory mechanical means. There is, however, the very serious difficulty which applies to all sheet metal, that it has no very great resistance to tearing or ripping. In a fabric which is made of distinct fibres, these fibres are able by a mutual displacement to reinforce each other in supporting a tearing effort. In the case of metals, however, no such adjustment is possible, and it is consequently found that any continuous material is liable to tear with relative ease. The relative behaviour of fabrics which are heavily dressed, and in which, therefore, the various fibres are held in position so as to be unable to reinforce one another, and of soft fabrics where the fibres are able to move, in regard to tearing, illustrates what has just been said. The question whether resistance to ripping is of serious importance in aeroplane wings, particularly under peace conditions, where they are not liable to be ripped by flying fragments of projectiles, is a matter to be decided by actual experiment in flight.

As distinct from the tendency just discussed of replacing wooden wing structures by corresponding structures made of metal, there is an alternative course which offers considerable promise of success. In this the actual wing covering is to be regarded as part of the wing structure and is to be made of such shape and dimensions as to be capable of supporting a share of the stresses which come upon the wing. A German all-metal aeroplane of the "Junker" type was provided with comparatively thick sheet metal wing covering having transverse corrugations, but it is anticipated that future developments in all-metal wing constructions will take a somewhat different direction.

Having dealt somewhat extensively with the applications of aluminium alloys to aircraft purposes, it is perhaps desirable to point out that those applications only constitute illustrations of the particular uses of which these alloys are capable, and that there are many possibilities in other directions where the remarkable properties of these materials would also offer very considerable advantages. In all vehicles and appliances, for instance, in which frequent starting and stopping is required, any reduction of weight must be of very considerable advantage. A very large proportion of the power used for our electric railways is expended in accelerating trains on starting, and in stopping them when a station is approached. The enormous amount of power required for these purposes is due to the fact that the actual weight or mass of the train is very large. To a considerable extent this mass is located in the under-frames and wheels of the vehicles, which are ordinarily made of steel or iron. In these parts of rolling stock, therefore, there would appear to be a very considerable field of possible usefulness for light alloys. Experimental work in that direction has been begun,

and it is hoped that in time, as engineers gain increasing confidence in aluminium alloys, their use for purposes of this kind will gradually extend. The use of car wheels made of aluminium alloy castings has already assumed considerable dimensions in America.

Finally, reference may perhaps be made to another possible application of light aluminium alloys in engineering work. In the largest bridges and roofs, it is well known that the greater part of the load which the structure has to bear consists of its own weight, the so-called live load or useful load, such as a railway train, representing only a small fraction of the weight of the structure itself. Actually, the longest possible span which can be constructed is limited by this consideration of the weight of the structure itself and the stresses which it imposes upon its members. The use of a material of very much lower density and of equal strength with mild steel, therefore, suggests the possibility of very greatly increasing the maximum possible span. There are, of course, not many situations in which these very huge spans would be required, but apart from that particular point, it must be borne in mind that the cost of a structure of large span is largely due to the fact that metal has to be provided mainly to bear the weight of the structure itself. It would certainly be possible to reduce this weight to a very considerable extent by replacing steel by aluminium alloys for those parts of the structure, at all events, which are responsible for the greatest development of stress in the remaining members. As an example of what is meant, the central portion of a cantilever bridge may be cited. This is really a small independent girder connecting the ends of the great cantilevers, and it is the weight of this central portion of the span which, to a large extent, governs the size and cost of the cantilevers themselves. By replacing this central span by a structure of aluminium alloy, a very large saving in the weight and cost of the steel constituting the rest of the structure could be effected, and it is, at all events, worth suggesting to bridge designers that the calculation of the relative cost of two structures, one made entirely of steel, and the other in which the central portion was made of a light alloy, is worth considering. Similar considerations also apply to roofs and other structures having exceptionally large span, where the weight of the structure itself enters largely into the cost of the material employed in building it. In the case of roofs, particularly, where the structure is protected from the action of the weather, the question of corrodibility does not enter seriously into the case. In any structure, however, the application of suitable protective coatings would be no more difficult in aluminium alloys than in the case of steel, and in the absence, at all events, of sea water, or spray derived from the sea, the relative permanence of an aluminium alloy structure and a steel structure, both properly protected, would not be very different.

In concluding this necessarily incomplete survey of aluminium and its alloys, and their engineering uses, it is desirable to state that while reference has mainly been made to work done and results obtained in the metallurgical laboratories of the National Physical Laboratory, it is not desired to suggest or to claim that the very great development of aluminium alloys during the years of war has been solely due to the work of that Laboratory. A very large amount of scientific research and experimental work up to a semi-manufacturing scale has been carried out there, and the staff of that department have taken a very active part in the development of light alloys. At the same time a large amount of work has also been done elsewhere, both at the Royal Aircraft Establishment at Farnborough and in various university laboratories, and in a large number of works, particularly in regard to the perfecting of processes of aluminium founding. There has been throughout a very free and helpful interchange of knowledge and experience, and many of the results achieved must be regarded as the product of joint effort.

FOREIGN COMPETITION.

Sir Robert Horne, President of the Board of Trade, was asked in Parliament on November 1st whether he was aware that the larger proportion of the hosiery machinery installed during the war is now standing, and that much unemployment exists in consequence of the enormous import of foreign goods of similar make. Sir R. Horne replied: "I know that unfortunately employment in the hosiery trade is not satisfactory, and that there have been considerable imports of certain descriptions of hosiery in recent months. In so far as these imports are sent here at dumped prices, the matter will be dealt with in the Anti-Dumping Bill which the Government has undertaken to introduce." Another question put to the Minister called for action to protect not only the British hosiery trade, but our lace and fabric glove trades from "dumping."

On the same day the attention of the Government was called to the rapid increase in the imports

of dye-stuffs into this country during the last few months. Mr. Evelyn Cecil asked the President of the Board of Trade whether they come in great part from Germany; and whether, having regard to the experience of the war and the importance of establishing a largely independent British industry of dyes and allied substances on grounds both of trade and national defence, His Majesty's Government would take further steps to safeguard its growth. Sir R. Horne's reply was as follows: "I am aware that the imports of dye-stuffs and intermediates into this country have increased very substantially during the last few months, and that a large proportion of these imports have been from Germany, though I must point out that these include a considerable quantity received from that country under the Reparation Clauses of the Treaty of Versailles. As regards the remainder of the question, I would refer my right hon. friend to the answer which I gave to my hon. friend the Member for Royton on July 20th last, to the effect that in the opinion of the Government, the existence of a strong synthetic dye-making industry is essential to the defence and security of the United Kingdom, and that in pursuance of the pledges given on several occasions, proposals to protect the industry for a time, so as to enable it to be placed on a secure foundation, will be embodied in a Bill relating to key industries, which will be introduced and proceeded with as soon as possible."

On November 9th Sir William Barton (Oldham) asked the President of the Board of Trade whether he was aware that dissatisfaction existed amongst users of colours for cotton textiles at the slow progress made by the British Dyes Corporation, Limited; whether he was aware of reported internal friction and dissensions in the technical directorate; and whether, in view of the national investment in this company, he would say what, if any, control was exercised by the House of Commons. Sir P. Lloyd-Greame replied to the question. He said that the British Dyestuffs Corporation was not at present, and was not likely to be for some considerable time, in a position to produce the whole range of dyestuffs required by the textile industries of this country, but in view of all the obstacles which had to be overcome he did not think there was ground for dissatisfaction with the progress that had been made. There had been some internal difficulties of a character not uncommon in the early stages of a large combination, but he was satisfied that every effort was being made by the directors to remove the difficulties in question. His Majesty's Government had two representatives on the board of directors, with special rights in order to secure the fulfilment of certain provisions of the memorandum and articles of association; but His Majesty's Government had no control beyond that of other shareholders over the internal management of the company.

A table presented to the House of Commons by Sir R. Horne shows that the value of goods, wholly or mainly manufactured, consigned to the United Kingdom from Germany during the nine months ended September 30th, 1920, was £17,190,793. It may be mentioned that the total value of imports from Germany in 1913 of articles wholly or mainly manufactured was £56,143,322.

EFFECTS OF SHORTER WORKING HOURS.*

The reports received from Inspectors show that the shortening of the working hours has had a beneficial effect on the operatives, perhaps more so than any other recent improvement in industrial conditions. The old system of long, dreary, monotonous toil is rapidly giving way to a new system of reasonable hours, so that soon it may be hoped that the overworked man or woman in the industrial world will rarely be found. On all sides workers are securing by their own efforts shorter hours, and many letters are received asking whether periods well within those allowed under the Factory Acts are legal.

Perhaps the classes of workers upon whom shorter hours will have the most beneficial effect will be the growing girl or boy on whom long periods of employment told hardly, and the worker possessing some vision and aspiration towards a fuller life. Regarding the former class the effect of reduced hours and the later morning start is more immediately evident. The pre-war hours of work often entailed very long absences from home—as, for example, in certain cotton districts where young boys and girls residing a long distance from the mills used to leave home before 5 a.m. and did not get back until 7 p.m. They were attracted to the mills by the high wages they could obtain there, and the long day was due to the want of good means of transit between their place of residence and the places where they worked. Now tram and train services frequently fit in better with the new hours, and the shortened day reduces the strain on the growing boy and girl. The gain to married women is also very great as is shown by the eagerness with which the older women in laundries respond to remarks about the shortened hours. It is a relief to them to be enabled to spend long evenings in their homes, and not have the early starts in the mornings.

With regard to the effect of shorter hours on time-keeping and absence from work, although it must be acknowledged that time-keeping depends largely on the character of the individual, and on the organisation, tone and discipline of the factory management, still it is not surprising to hear that better time-keeping has been the result of discontinuing work before breakfast. As far as absence for sickness and other reasons are concerned, there seems no doubt that a shorter working day results in the worker staying out less frequently. In one large factory the average daily absentees numbered some years ago forty; now, with a 44-hour week, the average number of daily absentees has dropped to ten. In a

* Extracted from "Annual Report of the Chief Inspector of Factories and Workshops for the Year 1919."

large laundry the Inspector reports there was a marked improvement in attendance, not only less sickness, but fewer cases of absence for general reasons such as attending to home affairs, the worker being better able to cope with these under the new hours of work.

Some interesting particulars of the reduction of lost time which followed the change to shorter hours at a large engineering works have been furnished. At this factory until last year the hours worked were 6 a.m. to 5 p.m., with 8 to 9 a.m. and 1 to 2 p.m. for meals, making a total of 54 hours. Last year the 47-hour week was adopted—7.30 a.m. to 5 p.m., with one hour for a meal at 12.30. In this factory about 1,200 men and boys were employed before the change, and on the average there were over 800 "quarters" lost weekly. This means that at least 800 workers commenced as late as 9 a.m. instead of 6 a.m. once a week, which was obviously an enormous hindrance to the work of others who came to work in time. In a typical week a few months ago only eighteen half-days were lost by the present staff of 1,500 men and boys. They were allowed grace until 7.40, after which they were shut out until the afternoon. Formerly only two to three minutes' grace was allowed at 6 o'clock, when the late-comers were shut out until 9 a.m.

With regard to the effect on health of the shortened hours, perhaps sufficient time has not yet elapsed for any marked improvement to be noted generally, although the improvement in individuals is evident. Less fatigue and overstrain is found in factories, and one Inspector reports that, although more men are employed in engineering and allied trades, the accident list has not increased, and it is claimed that fatigue is non existent; while another Inspector reports that the manageress of a laundry stated that she noted a perceptible decrease in sickness when she changed from the 8 a.m. to a 9 a.m. start.

It is also perhaps too early to generalise on the effect of the shorter hours in increasing the workers' taste for healthy recreation. It is reported that workers are appreciating the fact that they now have time to work in their allotments and gardens, and to play games or go for country rambles, while the leaders of some social clubs report bigger attendances in all classes, both technical and educational, and say that the members come to the classes fresher and keener than they were in previous years and make steadier advance.

Some occupiers and social workers have realised that the real well-being of the worker cannot be accomplished merely by working shorter hours, although this is a first and essential step as it frees the spirit and leaves some bodily and mental energy at the end of the day for recreation and education. Instead, they realise that the form this education and recreation is to take must be decided largely by the tastes of the workers, as individuals, and that a taste for healthy recreation and for education in varied forms can be encouraged by successful efforts or organisations in these respects in the factory and in outside clubs. Accordingly we have cases reported of successful works schools being carried on in factories, apprentices being allowed one day off a week to attend classes in technical and general instruction, and of firms who encourage outdoor exercises, games and recreations of all kinds. There is still, however, very much to be done in this direction, as the opportunities for wholesome recreation among the industrial classes, especially working girls, is at present very inadequate.

Clearly, the shorter working week brings with it new problems and responsibilities to both employer and worker.

The reports disclose wide differences of experience as to the production of the shorter hours. Frequently it is impossible to make a fair comparison of output before and after the shortening of hours of work, owing to other changes in conditions. Among these changes may be mentioned alterations in machinery or organisation, extensions of work necessitating the employment of much untrained labour, scarcity of workers (particularly of skilled workers), irregular supplies of materials, changes in quality or class of product and in systems of payment.

When the production depends almost entirely on the speed of machinery—as in cotton or woollen spinning—the output is said to be reduced in a proportion nearly, if not fully, corresponding to the reduction in hours. In other machine operations which call for constant alertness on the part of the operator (*e.g.*, weaving) output has not suffered to this extent, and, in exceptional cases, has scarcely been affected at all. In a third class of process, where output is largely or entirely dependent upon the exertion of the worker, there is frequently no loss in production; indeed, in one wholesale tailoring establishment an increase of 40 per cent. is reported (partly due to reorganisation); while in a boot factory, where the hours of work were reduced from fifty-two to forty-eight per week, there was a considerable increase in output. Unfortunately, a few of the reports indicate an extremely unfavourable result in some works, where the shortening of hours has been followed by a reduction in the hourly rate of production, and for this result no adequate explanation has, as a rule, been given.

In order to prevent or to reduce a decline in production, some employers have improved methods of work, and the two following instances may be quoted. One case is that of a silk-spinning and weaving factory, where, although the hours of work were reduced from forty-nine to forty-four per week, the output was increased. Careful records were kept of the output of each machine and worker, and any deficiency in individual output was closely investigated. This frequently brought to light slight defects in machinery which might otherwise have escaped attention, and further disclosed the fact that temperature had a considerable influence on production. It was also found that

some of the workers were not fitted for the work upon which they were engaged, and transference to other duties gave better results. Better methods of training young workers have also been adopted. Further, excellent arrangements have been made for the care of the operatives, including the appointment of a welfare staff and the provision of a rest-room. The second instance refers to the arrangements for cleaning machinery in a cotton-weaving shed containing 1,200 looms. As a rule, this cleaning is done by the weavers, and on Saturday morning the machinery is stopped for this purpose for half-an-hour before the recognised time for ceasing work. In the case in point the weavers do no cleaning whatever. Instead, the occupier has provided ten men cleaners, four being disabled ex-Service men and six elderly ex-weavers. For this service each weaver pays 3*d*. per loom per week, and the arrangement is stated to be highly satisfactory to both parties. The weavers are saved much dirty and uninteresting work, and the looms and shed are in a very much cleaner condition than obtains under the old system. The employer nominally loses £15 per week on this arrangement, but he and the workers are the gainers by a greater output of better quality. Incidentally, the new system removes the temptation to weavers to clean looms while in motion and thus reduces the risk of accident.

GENERAL NOTES.

ZINC ORES IN AUSTRALIA.—It is reported from Hobart that the Electrolytic Zinc Company is continuing its policy of works extension. The proposal is to increase the capacity of the plant at Risdon from 14 tons per day to 100 tons per day, the ultimate outlay on these works being £1,500,000. The ores at present dealt with at Risdon came from Broken Hill, N.S.W. It is believed that when the full plant is installed 50 per cent. of Broken Hill concentrates will be treated within Australia.

MAURITIUS.—At the present time Mauritius is, for its size, one of the wealthiest countries in the world. The prosperity of the sugar industry, according to *United Empire*, is extraordinary, and it is estimated that more than Rs. 200,000,000 will be received for sugar alone during the coming year. Added to the wealth of the last three years, this makes a small community like the inhabitants of Mauritius extremely wealthy. Mauritius planters have unanimously agreed to sell their last sugar crop to Great Britain at a maximum price of £90 per ton, in spite of much higher offers from America and other countries.

MEETINGS FOR THE ENSUING WEEK.

MONDAY, NOVEMBER 22 ... Pottery and Glass Trades' Benevolent Institution, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. M. W. Travers, "Glass in Connection with the Lamp Blown Glass Trade." (Lecture III.)

British Women's Patriotic League, South Lodge, Rutland Gate, S.W., 3 p.m. Mr. H. Dubery, "The Distribution of the National Wealth."

Aeronautical Engineers, Institute of, Royal College of Science, South Kensington, S.W., 8.30 p.m. Mr. S. T. G. Andrews, "The Education Act of 1918."

Geographical Society, 135, New Bond-street, W., 8.30 p.m. Major F. M. Bailey, "A Visit to Bokhara in 1919."

Electrical Engineers, Institution of (North Midland Section), Mappin Hall, Sheffield, 7.30 p.m. Professor E. H. Crapper, "Permanent Magnets."

East India Association, Caxton Hall, Westminster, S.W., 3.30 p.m. Dr. J. Ph. Vogel, "The Preservation of Ancient Monuments in India."

TUESDAY, NOVEMBER 23...Petroleum Technologists, Institution of, at the ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 5 p.m.

Botanic Society, Inner Circle, Regent's-park, N.W., 3 p.m. Professor A. W. Bickerton, "The Relations of Astronomy to Botany." (Lecture III.)

Sociological Society, 65, Belgrave-road, Westminster, S.W., 5.15 p.m. Mr. C. R. Enock, "Suggestions towards a Science of Corporate Life."

Anthropological Institute, at the Royal Society, Burlington House, W., 8.30 p.m. (Huxley Memorial Lecture) Dr. A. C. Haddon, "Migrations of Cultures in British New Guinea."

Electrical Engineers, Institution of (North-Western Section), 17, Albert-square, Manchester, 7 p.m. Mr. W. B. Woodhouse, "The Distribution of Electricity."

Royal Dublin Society, Leinster House, Dublin, 4.15 p.m. Professor H. H. Dixon and Mr. N. G. Ball, "A Determination of the Heat produced during the Inversion of Sucrose by means of a Differential Calorimeter."

WEDNESDAY, NOVEMBER 24...ROYAL SOCIETY OF ARTS, John-street, Adelphi, W.C., 8 p.m. Dr. F. W. Edridge-Green, "Colour Vision and Colour Blindness."

British Academy, at the Royal Society, Burlington House, W., 5 p.m. Professor H. J. C. Grierson, "Lord Byron, Arnold and Swinburne."

Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. Address to the Wireless Section by Dr. W. H. Eccles.

Chemistry, Institute of, University College, Gower-street, W.C., 8 p.m. Mr. J. T. Wood, "Some Scientific Aspects of Tanning."

University of London, Gower-street, W.C., 5.30 p.m. Mr. G. Whale, "The Discovery of Britain."

THURSDAY, NOVEMBER 25 ... Electrical Engineers, Institution of, at the Institution of Civil Engineers, Great George-street, S.W., 6 p.m. 1. Mr. W. B. Woodhouse, "The Distribution of Electricity." 2. Mr. R. O. Kapp, "Some Economic Aspects of E. H. T. Distribution by Underground Cables."

Concrete Institute, 296, Vauxhall Bridge-road, S.W., 7.30 p.m. Presidential Address by Mr. E. F. Etchells.

China Society, at the School of Oriental Studies, Finsbury Circus, E.C., 5 p.m. Dr. W. M. M'Govern, "Life in a Buddhist Monastery."

FRIDAY, NOVEMBER 26 ... North-East Coast Institution of Engineers and Shipbuilders, Westgate-road, Newcastle-on-Tyne, 7.30 p.m. Engineer-Commander C. J. Hawkes, "Some Experimental Work in Connection with the Injection and Combustion of Fuel in Diesel Engines."

Electrical Engineers, Institution of (Students' Section), Technical College, Leonard-street, E.C., 6.30 p.m. Mr. A. J. C. Watts, "Electricity and the Paper-Making Industry."

Physical Society, Imperial College of Science, South Kensington, S.W., 7.50 p.m. (Joint Meeting with the Optical Society) "The Making of Reflecting Surfaces."

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